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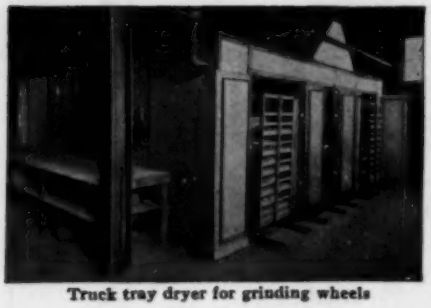

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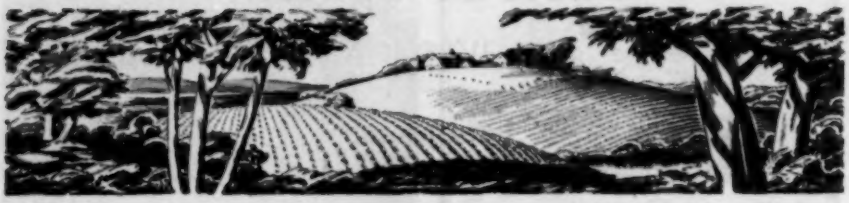

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REFRACTORIES FOR USE IN SULPHATE-RECOVERY FURNACES OF THE PULP AND PAPER INDUSTRIES*

By J. A. Cunliffe and H. E. Clem

ABSTRACT

The paper gives a short review of the soda-recovery methods used in the Kraft process. The tests made to determine the relative merits of different refractories were (1) P.C.E. determinations of soda-refractory mixtures, (2) simulative-service slag tests, and (3) petrographic analyses. Tests indicate that resistance is produced by (1) an impervious crystalline structure, such as soapstone for the low temperatures and electro-cast mullite for the high temperatures, or (2) chemical inertness in contact with soda, such as is found with purer forms of magnesia.

I. Introduction

During the last few years radical changes have been made in the methods used for recovering waste "sulphate liquor" in the pulp and paper Kraft process. Chief among these changes was the introduction of the "Wagner recovery furnace," an integral part of the patented "Wagner recovery system."

With the Wagner recovery system came the problem of finding a refractory for the recovery furnaces that could withstand extreme chemical and some physical stresses. None was entirely satisfactory.

II. Methods for Recovering Sodium Sulphate

In the pulp industry the wood chips are digested with a hot alkali solution to remove the noncellular portion of the wood. This process leaves the fibers which are used for the paper untouched. In the sulphate or Kraft process, sodium sulphate is the digesting agent For reuse the "black liquor" from the digestors must be purified: the water, wood lignin, and other carbonaceous materials separated out.

In the Wagner recovery process the waste black liquor is evaporated by superheated steam in a closed system until it contains 70 to 72% solids. This concentrated liquor is sprayed into furnaces heated to high temperatures and ignited by the flame of a removable oil burner. The water in the liquor is immediately vaporized and passes out with the gases. The carbonaceous material and inorganic salts, in the form of a desiccated black ash, fall to the bottom of the furnace, where they are burned in an air blast. The sodium salts melt, trickle to the bottom of the furnace, and are drawn off into a tank of water, where they are immediately dissolved with explosive violence. After an addition of sodium sulphate

* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Refractories Division). Received February 26, 1932. From a thesis submitted as a partial requirement for the degree of Bachelor of Science in Ceramic Engineering, University of Washington, Seattle, Wash.

they are again ready for use in the form of a soluble noncombustible solution.

III. The Wagner Furnace

The Wagner furnace is either a circular steel shell with a refractory lining, or often merely a wall of refractory material, 12 to 18 inches thick, surrounded by supporting tie-rods. The furnace varies in height from 22 to 30 feet and in diameter from 9 to 12 feet (see Fig. 1).

The internal wall temperatures range from 2200 to 2400°F. Many actions contribute to the attack of the furnace lining: (1) high velocities of hot gases, (2) chemical action of volatilized soda salts, (3) action of water vapor at high temperatures, (4) abrasion of solid carbon, and (5) slagging action of fused salts of sodium.

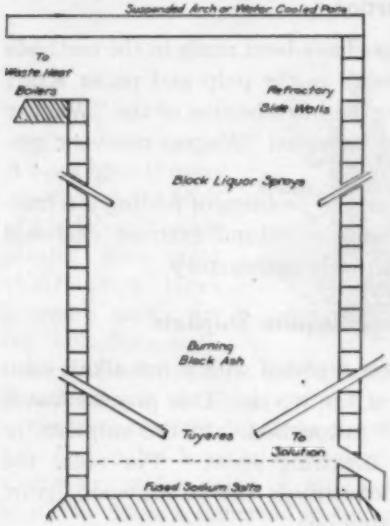

FIG. 1.—The Wagner furnace.

Soapstone blocks are most generally used. The soapstone lining has a maximum life of only ten to twelve months. The rebuilding cost on the Pacific Coast is about $10,000 per furnace. Since each plant usually has about five furnaces, the furnace maintenance cost is high.

IV. Pyrochemical Tests with Soda Slag

The furnace temperatures in one plant were found to vary in different parts of the combustion zone between 2200°F and 2400°F. The so-called soda ash recovered contains sodium carbonate, sodium sulphide, sodium oxide or hydroxide, and sodium sulphates.

The pyrochemical activity of this soda ash was determined by the pyrometric cone equivalent method applied to mixtures of the refractories with the soda compound.

A sample of recovered soda compound taken from a commercial furnace was mixed with refractories in a series with increasing proportions of soda. The refractories tested in this manner were periclase, kaolin, Virginia soapstone, diaspore, silica, magnesia, chrome, spinel, and mullite.

Both the soda compound and the refractory were ground to pass a 100-mesh screen, made into cones in the usual manner, and fired in an oil-heated furnace between cones 3 and 20 to cover the temperature used in a Wagner furnace. The firing rate was about 800°C per hour to cone 12,

and about 350°C per hour above cone 12. The P.C.E. value of each test cone was noted and plotted against the concentration of soda material in the cone. A re-check firing of each series was made. Portions of the curves which lie outside the composition and temperature ranges used are shown by dotted lines (Fig. 2).

(1) Results of Pyrochemical Tests With the exception of magnesia, periclase, and spinel, all the materials had a minimum P.C.E. value with about 15% soda compound. This seems significant and perhaps indicates the formation of a eutectic near this concentration.

(2) Silica Brick The soda-silica brick results paralleled Kracek's data on the binary system sodium oxide–silica,[1] even though the soda compound was not pure and the cone fusions did not always coincide with melting temperature data. The fusion temperature of silica brick (Fig. 2) was reduced to cone 3 at a 20% concentration of the soda compound.

(3) Periclase and Spinel Only one fusion temperature was found for periclase and spinel (Fig. 2) between P.C.E. 3 and 20. This was at the 75% concentration of soda compound. All other mixtures of the two refractories tested had a P.C.E. above 20.

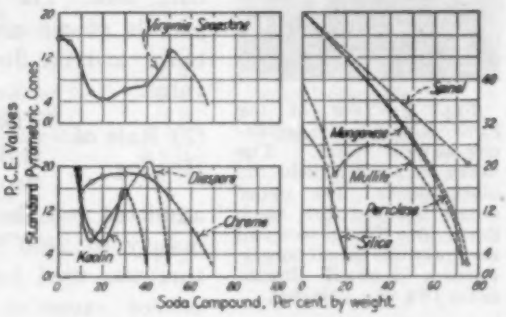

FIG. 2.—P.C.E. values obtained (and extrapolated) of mixtures of "soda" and refractory ground to 100-mesh.

Within the ranges studied, no sign of eutectic formation was shown.

The crystalline structures of these materials may partially account for their high resistance to fusion with soda. No compounds of magnesia and soda or of sodium and magnesium aluminate are known to the writers. Their high P.C.E. with proportions of soda indicated an excellent service in soda-recovery furnaces if pyrochemical resistance alone were required.

(4) Dead-Burned Magnesia Dead-burned magnesia brick (Fig. 2) showed but one point on the curve below P.C.E. 3, at the 75% soda concentration. The remaining P.C.E. values were all above 20. The curve indicates that magnesia will have excellent pyrochemical resistance in the Wagner furnaces.

[1] F. C. Kracek, "The System Sodium Oxide–Silica," *Jour Phys. Chem.*, Vol. 34, 1930.

V. Simulative Slag Tests and Petrographic Examinations

(1) The Test Furnace Test panels of 9-inch standard brick were erected in a laboratory furnace (see Figs. 3 and 4). Two refractories were tested at the same time by placing them on opposite halves of the furnace. Each brick was measured before being placed in the furnace and its surfaces were ground to insure close contact. The mortar in some cases was furnished by the refractory manufacturer, while in other cases a fireclay mortar was used.

FIG. 3.—View of the furnaces used in the simulative-service tests. The tanks on the left held the black liquor. The upper nozzle sprayed the black liquor into the furnace and the lower was the oil burner. Furnace internal dimensions, 18 x 48 x 30 inches.

The oil flame was directed at the center of the intersection of the back walls and the bottom of the furnace. The black liquor spray intersected the oil flame about 9 inches from the back wall. The black liquor was fed by 20 pounds of air pressure alternately from two tanks and the flow was regulated by a needle valve.

(2) Rate of Heating The furnace was heated approximately to 1900°F (1040°C) in two hours. The liquor was then admitted and the temperature raised approximately to 2400°F (1320°C). This temperature was used for the first four tests but it proved excessive for the soapstone, so the remainder of the tests were run at about 2100°F (1150°C). It was found that 35 hours was a sufficient amount of time to show differential slagging results.

During the tests an average of about 75 gallons of black liquor containing 61 to 72% solids were used.

(3) Cooling and Sample Removing At the end of the 35-hour period the liquor was shut off and the fused sodium salts were drained from the bottom of the furnace to facilitate the removal of the panels after the furnace had cooled.

FIG. 4.—A view of the panels in the testing furnace before testing.

(4) Obtaining Data The test panels were removed and each brick measured to determine the amount of erosion. Each brick was broken into halves and several measurements were taken between the slag lines on opposite sides of the

brick. The average loss divided by the original thickness gave the percentage loss for each brick (see Table I).

The samples were examined for slag penetration, alteration of the original material, formation of new compounds, and the nature of the slag. For chemical analyses see Table II. For the petrographic study, thin sections[2] were prepared.

TABLE I

SUMMARY OF RESULTS OF SIMULATIVE-SERVICE SLAG TESTS

Test No.	Av. temperature (°F)	Black liquor (gal.)	Materials	Original absorption (%)	Slagging loss (%) Max.	Min.	Av.
1	2460	70	Spinel	13.5	11.4	5.1	8.3
			Wash. flint fire clay	10.7	22.2	8.5	13.6
2	2680	60	Spinel	13.5	7.9	1.1	4.7
			Mullite	0.3	0.9	0.0	0.4
			Periclase	13.5	4.8	2.9	3.8
3	2440	80	Pa. flint fire clay	9.4	26.0	11.0	16.4
			Kaolin	14.0	28.6	13.6	20.2
4[a]	2395	80	Silica	12.4	Both materials completely failed		
			Va. soapstone	0.2			
5	2000	85	Va. soapstone	0.2	20.1	7.3	11.4
			Mo. flint fire clay	[b]	Failed completely		
6	2075	75	Diaspore	15.0	27.6	3.2	15.8
			Chrome	7.6	1.4	−7.0	−1.7
7	2080	70	Magnesia	[b]	0.0	0.0	0.0
			Va. soapstone	0.2	11.8	6.8	8.8
8	2220	90	Magnesia[c]	[b]	0.0	0.0	0.0
			Mullite[d]	0.3	3.8	1.1	2.6

[a] Tested only 30 hours.
[b] Absorption not determined.
[c] Material previously used in test No. 7
[d] Material previously used in test No. 2.

TABLE II

CHEMICAL ANALYSES OF REFRACTORIES IN THE SIMULATIVE-SERVICE SLAG TEST

(Furnished by manufacturers)

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O K_2O	TiO_2	H_2O	Total
Wash. fireclay	56.99	38.39	3.99	1.01	0.25				100.63
Cast mullite	23.24	71.21	0.55		0.26	1.68	3.79		100.73
Soapstone[a] (Va.)	39.06	12.84	12.93	5.98	22.76			6.56	100.13
Kaolin	56.20	28.90	1.58	0.24	0.30		2.80		100.06
Diaspore	22.80	70.32	1.89	0.34	0.46	0.90	3.27		99.98
Mo. fire clay	56.05	40.07	2.40	0.40	0.40		0.66		99.98
Pa. flint fire clay	52.28	42.49	1.55	1.20	0.32	not det.	3.00		99.84
Chrome[a]	5.88	19.49	17.68		16.30		Cr_2O_3 50.65		100.00
Magnesite[a]	4.30	3.14	4.78	3.88	83.87				99.97

[a] Not the same material as in test, but similar.

[2] The photographs were made with a Zeiss camera placed over the eyepiece of a petrographic microscope. The magnification was 80 diameters and the exposure varied from 3 to 40 minutes for different materials. The light was provided by a special 400-watt lamp and was passed through a colorless gelatine filter.

FIG. 5.—Spinel (left), Washington flint fire clay (right). The furnace after the first test was run at an average temperature of 2460°F (1350°C). The spalling of the spinel is apparent, and bulging can be seen on the faces of the two top brick on the left. The fire clay was attacked severely. The corners of the brick were rounded and the brick were pitted. Two of the brick in the panel on the right fell into the bath.

VI. Results of Simulative-Service Slag Tests and Petrographic Examination

(1) Spinel ($MgO \cdot Al_2O_3$) These brick were made from spinel which had been produced by melting magnesia and alumina together in an electric furnace. The structure was rather weak and the absorption rather high (13.5%). In the first test the spinel spalled severely at high temperatures during the application of the soda compound and in some cases surface layers 3/8 inch thick bulged out or spalled off. (See bulging surfaces on left side of Fig. 5.) The slag loss was 8.3%.

The refractory originally consisted of grains or crystals of spinel bonded, perhaps, with more finely ground spinel. The liquid slag has penetrated the brick between the grains of spinel. It has attacked the bond but not the larger grains of spinel. The spalling was apparently caused by a new crystalline combination between the entering sodium salts and the bonding material, and the growth forced the spinel crystals apart. The minerals that were formed could not be determined.

(2) Washington Flint Fire Clay The Washington flint fire clay (Fig. 5), absorption 10.7%, slagged away considerably during the test. The corners and joints were rounded and the edges badly eaten. Below the slag line the salts penetrated the brick. Above the slag line a black discoloration which appeared to be finely-divided carbon was distributed throughout the brick, indicating a highly reducing atmosphere in the furnace during the test. The slag loss was 13.6%.

The thin section of the Washington

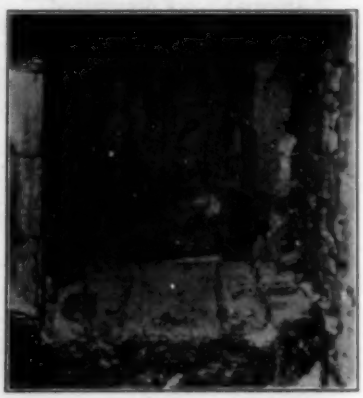

FIG. 6.—Mullite (left), spinel and periclase (right). The materials in this test, which were run at an average temperature of 2680°F (1470°C), withstood the action very well. The brick marked "P" on the right are periclase, the other two, spinel. Three other spinel brick fell into the bath but were not severely attacked.

flint fireclay brick was made with difficulty as the structure was entirely broken up and softened due to penetration by sodium salts. Penetration and assimilation with fusion caused the failure of the refractory. These types of fireclay bodies seem to be unsuitable for resistance to the slags of sodium salts.

(3) Periclase Brick (MgO) The periclase brick[3] (Fig. 6), absorption 13.5%, withstood the direct action of the sodium salts fairly well, but at the high temperatures of the test, the crown of the furnace was severely attacked by the vapors, producing a liquid mixture of sodium salts and more siliceous clay materials which dripped on the brick and attacked them. The action was not severe enough to impair the results but it was noticeable. The average slagging loss was only 3.8%.

The periclase crystals themselves were not attacked by slag penetration, but much of the bonding material was replaced by the products of slag attack. The replacement material was part yellowish glass, part crystalline.

(4) Mullite Brick The mullite brick[4] (Fig. 6) withstood the soda action well, giving average slag losses of 0.4% in the first test and 2.6% in the second test of the same brick. The dense structure of the brick (absorption 0.3%) prevented the fused salts from penetrating and coming into contact with more than the outer surface, thus perhaps explaining the small amount of erosion.

FIG. 7.—Photomicrograph of section of mullite brick which has passed through simulative-service slag test. Magnification 80 ×. S_1 is glassy slag, S_2 is a mixture of slag and partly assimilated crystals, and B_1 is the brick proper, showing carbon darkening.

The body is very dense consisting entirely of fine, very closely interlocking crystals of mullite, which seems to account for the resistance to slagging by soda salts (Fig. 7). The slag interface is characterized by a smaller number of crystals with more glassy slag. Just inside the brick-slag interface there was a darkening of the structure which was due to a carbon migration toward the brick surface. The carbon enters the brick during manufacture. The depth of penetration was only 0.2 mm., showing that it plays no appreciable part in the small amount of assimilation.

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[3] This periclase was made in an electric furnace from magnesia. It was then crushed and made into brick. The bonding material, if any, is not known to the writers.

[4] Made by casting the molten material from an electric furnace directly into brick molds.

(5) Pennsylvania Flint Fire Clay The Pennsylvania flint fireclay brick (Fig. 8) were hand-made brick of 9.4% absorption, and were attacked somewhat irregularly. The action was much more intense below the slag line than above. Above the slag line the interior of the brick was discolored by a carbonaceous deposit. Toward the end of the test two side brick fell, but they were not in the bath long enough to be attacked more than those left standing. The average slagging loss was 16.4%.

It was extremely difficult to make a thin-section of this material as the refractory was very weak and fragmental after the test. This condition was caused by the penetration of the sodium salts and the assimilation of the bond between the larger grains. The interface shows that the assimilation of the grains likewise produced a liquid of low viscosity, which ran down the face as soon as it formed. This rapid removal of the products of reaction was probably the cause of the great loss in thickness during the test. The minerals formed were indeterminable because of their slight crystallinity.

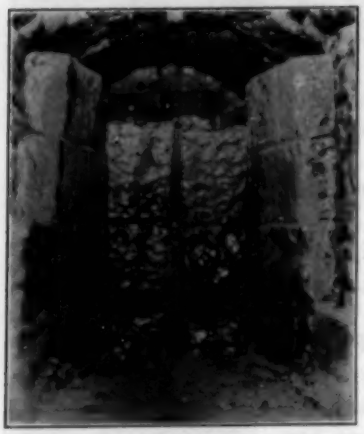

FIG. 8.—Pennsylvania flint fire clay (left), kaolin (right). Both of the above materials have been badly eaten in the test at an average temperature of 2440°F (1335°C). Three of the kaolin and two of the flint fireclay brick fell into the bath. These fallen brick had been removed before the picture was taken.

(6) Kaolin Brick The kaolin brick (Fig. 8) slagged away considerably and had deep holes eaten into them. The edges and corners were much rounded by the action of the sodium salts. The slag did not penetrate the brick below the slag line, even though the absorption was 14%. The average slagging loss was 20.2%. Carbon was deposited in the brick below the slag line and a few iron slag spots appeared, probably due to a concentration of the original iron in the brick in a reducing atmosphere.

Petrographic examination showed that the brick was full of small cavities. The slag at the interface was a colorless glass, and the failure of the refractory seemed to be due to the formation and easy penetration of a very fluid and chemically active slag, with rapid removal of the solution products. The action was shown by the reaction rims around the grains near the slag interface.

(7) Silica Brick The silica brick (Fig. 9) were almost entirely dissolved in the slag bath before the test was finished, and only a few remnants were left standing. The silica brick were originally very

porous (12.4% absorption) and the slag penetration was rapid. Petrographic examination showed that even the interior grains were surrounded by products of assimilation of silica by the slag, and reaction rims showed around them. Excess liquid of low viscosity was produced within the refractory, causing fusion and solution. The crystalline structure of the cristobalite was destroyed, leaving dark glassy grains in its place. The destruction was perhaps partly due to the spalling of the brick, although none was noted during the test.

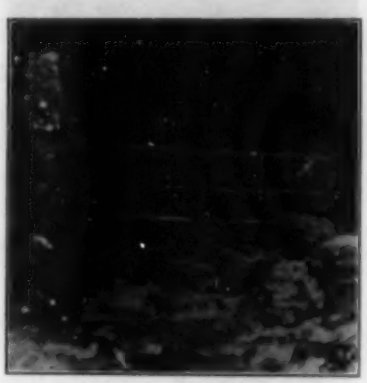

FIG. 9.—Silica (left), soapstone (right). This test was too severe for silica and soapstone. The temperature, 2395°F (1315°C) was excessive for the soapstone. Three of the silica remain standing, but were so badly eaten that no measurements could be taken. The fireclay brick at the rear form a bagwall of the furnace.

(8) Virginia Soapstone Brick

The Virginia soapstone brick in the same test as the silica brick (Fig. 9) were practically destroyed. The temperature of this test was 2395°F and was excessive since the fusion temperature of the soapstone was 2426°F. The same material in test No. 5 at a lower temperature stood up well (see Fig. 10). Due to the low absorption of the brick (0.2%), the attack was confined to the face. In test No. 7 (Fig. 12), some slagging of the soapstone occurred (8.8%).

FIG. 10.—Soapstone (left), Missouri flint fire clay (right). Almost complete failure of the Missouri flint fireclay brick is shown in this view. Soapstone was affected, but not so severely. The average temperature of the tests was 2000°F (1095°C).

The Virginia soapstone was very massive and dense, and showed no cleavage planes. The slag was mostly glassy, but near the contact of the brick it was finely crystalline. The crystallinity of the slag and the solution of the brick at the face showed that assimilation and formation of new compounds took place. The resistance of the brick was due to low absorption which allowed attack only on the face.

(9) Missouri Flint Fire Clay

The Missouri flint fireclay brick (Fig. 10) failed before the test was finished, although the brick had been selected because of their greater density and degree of vitrification. No measurements

FIG. 11.—Chrome (left), diaspore (right). In this view of test No. 6 which was run at an average temperature of 2075°F (1135°C), the diaspore was affected severely. The action of the salts caused the brick to expand and flake off in small layers. The chrome brick show a slight bulging.

could be taken because most of the specimens recovered were so irregular that they could not be measured with any degree of accuracy. The penetration and chemical attack were similar to those of other fireclay brick.

(10) Diaspore Brick The diaspore brick (Fig. 11), absorption 15.0%, expanded and peeled in the test due to the absorption of sodium salts and reaction with the alumina of the brick. In one case in commercial practice it was reported that the formation of a volatile, sodium-aluminum compound caused the destruction of the boiler tubes, heated by waste gases from a Wagner furnace containing diaspore brick. The peeling loss was 15.8%.

The thin section showed that penetration of slag has taken place throughout the brick. The spalling can be traced to the penetration of soda slag into the brick with partial assimilation of the diaspore grains and consequent formation of new compounds. The growth of these compounds has torn apart the bonds of the brick and disrupted the structure.

(11) Chrome Brick The chrome brick (Fig. 11), absorption 7.6%, did not show much slagging but gave a measurable expansion (1.7%). The expansion of the chrome brick is the greatest objection to it in actual practice. In one instance it was reported that a furnace of chrome brick 30 feet high expanded to 33 feet with disastrous results.

The petrographic examination showed the cause of expansion. Penetration of the refractory had taken place throughout, and there had been reactions

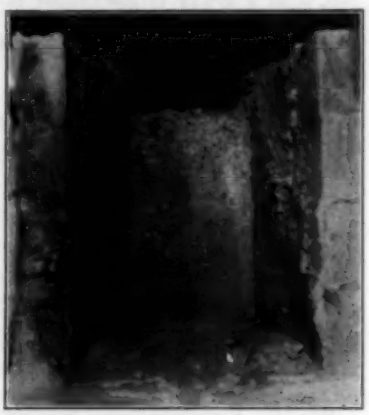

FIG. 12.—Soapstone (left), unfired magnesia (right). Both of the materials stood up well in the test, the average temperature of which was 2080°F (1138°C). The rough appearance of the magnesia brick is due to drippings from the crown of the furnace and not from the test brick. Soapstone was affected, but not severely.

between the slag and portions of the refractory with the formation of new compounds. The cavities were filled with a colorless anisotropic material, especially near the interface of brick and slag. A yellowish tinge appeared around some of the grains, and some very small, reddish grains, probably sodium ferrate, appeared. The growth of new crystals takes place faster than the assimilation of the grains; therefore expansion rather than slagging takes place. In time this would cause failure of the refractory.

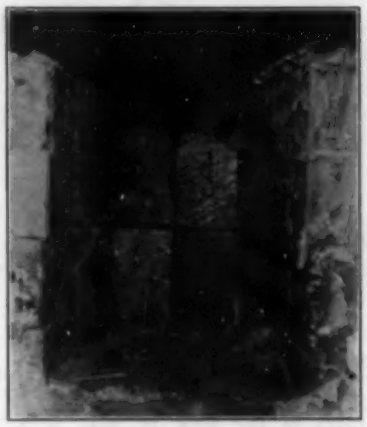

FIG. 13.—Mullite (left), unfired magnesia (right). Again both materials are in almost perfect shape, after a test at an average temperature of 2220°F (1215°C). The magnesia brick were left in place from the previous test. The mullite brick from test No. 2 were placed in the furnace for a second test. The cracks in the mullite were caused by the first removal from the furnace.

(12) Magnesia Brick The magnesia brick (Fig. 12) used in this test was a new product. It is reported that dead-burned magnesia is mixed with a bonding material and subjected to pressures up to 10,000 pounds per square inch. The brick were not fired and the bonding material is not known. No slagging action was noted in the specimens tested. A second test of the same materials was made with mullite to determine whether prolonging the action would produce different results. Still no action was noticeable.

FIG. 14.—Comparison between the materials before and after the simulative-service slag tests.

(1) Diaspore is one of the materials not suited for use in the Wagner furnaces. The peeling of the brick is clearly shown. (2) Kaolin is also unsuitable. The view shows the amount that has been slagged away during one 35-hour test. (3) Periclase appeared to be one of the better materials. Only a slight action was apparent in the brick. (4) Spinel appeared in some cases to be eaten and in others to expand. In this view the spinel has expanded; the lower half spalled off and was replaced with slag.

From a petrographic examination it could be seen that the greenish, yellow-colored, glassy slag had penetrated into the brick, but the grains of the magnesite were very closely packed and no disruption took place although the grains of magnesite had changed to small colorless crystals of periclase after contact with the slag. No fusion was noted within the brick.

(13) Mullite and Magnesia These materials were both placed in the last test (Fig. 13), after having been through a previous test.

Magnesia showed no effect in the second test, and mullite showed only a slight slagging (2.6%). Petrographic examinations were made after the second test.

Comparisons of all the brick after and before the simulative-service slag tests are shown in Figs. 14, 15, and 16.

FIG. 15.—Comparison between the materials before and after the tests. (1) Silica was severely slagged. (2) Pennsylvania flint fire clay appears in the view to have withstood the action fairly well, but Fig. 12 shows that the material was pitted severely. (3) Soapstone was attacked on the surface but was not otherwise affected at the lower temperatures. (4) Washington flint fire clay was attacked severely at the higher temperatures.

VII. Summary

(1) The inertness of refractories to the disintegrating conditions encountered in the Wagner soda-recovery furnaces is due to two types of resistance: (1) resistance to chemical attack which causes either (*a*) solution and fusion or (*b*) the growth of expanding soda compounds producing swelling or spalling; and (2) structural resistance produced by a dense, impenetrable body.

(2) Three tests were used to determine the suitability of a refractory for resistance to disruption in soda-recovery furnaces: (*a*) The P.C.E. or cone fusion test gave an idea of the chemical resistance to soda-slag fusion. (*b*) The simulative slag test with full-sized brick indicated the combined chemical and structural resistance. (*c*) The petrographic examination gave data on internal attack.

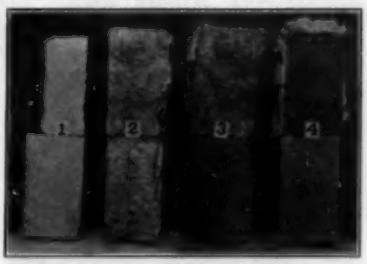

FIG. 16.—Comparison between the materials before and after the simulative-service slag tests. (1) The specimen is one of the remnants of the Missouri flint fire clays shown in Fig. 17. (2) Mullite was little affected by two tests. The depressions are blowholes which were formed in the original electro-casting process. (3) The chrome brick has expanded considerably and has also been attacked slightly. (4) View of the special, unfired magnesia brick which withstood the action very well.

(3) Fireclay, kaolin, and silica brick gave poor resistance in these tests because of their chemical reactivity with soda and their porous structure. While the glass did not penetrate the clay brick beyond the zone of reaction, very little resistance was offered to solution and plucking. Diaspore brick were unsuitable because of the disruptive expanding growth of new compounds formed by chemical reaction with soda. The spinel brick likewise were subject to expansion although their chemical resistance was excellent. Chrome brick also expanded from the growth of new compounds.

Soapstone owed its resistance at lower temperatures to its impenetrability, but softened of its own accord above 2400°F. Periclase brick were resistant because of their nonreactive composition, but the bond of the samples tested was attacked by the sodium salts. Electro-cast mullite brick, although chemically reactive with soda, owed their resistance to a dense, interlocking, crystal structure. The special magnesia brick owed their resistance to chemical inactivity with soda at high temperatures.

(4) The tests indicated that periclase, mullite, and special magnesite are worth continued investigation on a commercial scale, since the testing of these materials indicated a superiority over soapstone, which has been used more than any other refractory in the soda-recovery furnaces.

Acknowledgment The writers wish to acknowledge their indebtedness to Hewitt Wilson for his supervision, suggestions, and corrections, both in the testing and in the writing of this paper. Thanks are also due to the manufacturers of refractories who supplied the samples for testing and assisted with suggestions. The following paper companies of Washington kindly supplied the black soda liquid: Longview Fibre Company, Longview, Wash.; St. Regis Kraft Company, Tacoma, Wash.; Crown and Willamette Paper Company, Camas, Wash.; and the National Paper Products Company, Port Townsend, Wash.

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CERAMIC ENGINEERING
UNIVERSITY OF WASHINGTON
SEATTLE, WASH.

NOTES ON ELECTROMETRIC IRON DETERMINATION*

Iron in Feldspar

By A. K. Lyle, Jr.

ABSTRACT

Results are presented showing the variable effect of platinum on the determination of iron in feldspar. Most of the platinum is introduced during the pyrosulphate fusion. The use of vitreous silica crucibles for the fusion reduces the platinum contamination so that the results are well within the required limits of accuracy.

I. Introduction

The recommended methods for the determination of iron in glass sand and in feldspar provide for the removal of platinum before proceeding with the potentiometric titration. To a ten-gram sample of sand or feldspar, hydrofluoric and sulphuric acids are added and the solution is evaporated to complete dryness. The residue is digested with dilute hydrochloric acid and filtered. The residue remaining from the sand is fused with sodium carbonate and that from the feldspar with potassium pyrosulphate. The melt is dissolved in dilute hydrochloric acid and added to the rest of the solution. After making the solution just acid with sulphuric, the platinum is removed with hydrogen sulphide. It is necessary to let the solution stand overnight. The solution is filtered, its volume reduced, and the acid made 1:1 with hydrochloric acid. The iron is reduced with stannous chloride and titrated potentiometrically with standard dichromate.

For routine determinations of iron in sand, the removal of platinum may be omitted. A large number of results from this laboratory indicate an accuracy of 0.3 mg. Check samples, whether by the same or different analysts, seldom differ by more than this amount.

II. The Effect of Platinum

Platinum is probably the chief source of error since the amount introduced is variable. Some of it comes from the hydrofluoric and sulphuric acid evaporation and some from the fusion with carbonate or pyrosulphate. The amount introduced by the acid evaporation is probably small since sulphur dioxide formed by the oxidation of the organic matter, nearly always present in the sample, inhibits its reaction with the platinum.[1]

The sodium carbonate fusion introduces only a small portion.[2]

The pyrosulphate fusion necessary to complete the solution of feldspar introduces a fairly large and variable amount of platinum. Washington estimated that a platinum crucible lost 2.5 mg. for each fusion. The

* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Glass Division). Received March 14, 1932.

[1] Hillebrand and Lundell, Applied Inorganic Analysis, p. 19.

[2] H. S. Washington, Chemical Analyses of Rocks, 4th ed., p. 188.

amount of platinum dissolved depends upon the time and temperature of the fusion and upon the composition of the residue. Table I shows the results of iron determinations using Bureau of Standards soda feldspar No. 99. The pyrosulphate fusion was made in platinum, and the results include the dissolved platinum.

TABLE I

DETERMINATION OF Fe_2O_3 IN BUREAU OF STANDARDS SODA FELDSPAR NO. 99
RESIDUES FUSED WITH POTASSIUM PYROSULPHATE IN PLATINUM

No.	Fe_2O_3 in sample (gram)	Fe_2O_3 found (gram)	Difference (gram)[c]	Per cent corrected by av. difference	Error (%)
1	0.0065	0.0080	0.0015	0.068	+0.003
2	"	0.0081	0.0016	0.069	+0.004
3	"	0.0073	0.0008	0.061	−0.004
4	"	0.0074	0.0009	0.062	−0.003
5[a]	None	0.0010	0.0010		
6[b]	0.0102	0.0127	0.0025		

[a] Blank using reagents only.
[b] Blank using 25 ml. standard ferric chloride solution.
[c] Average difference of feldspar results is 0.0012 gram.

The variation is quite evident. The method is not accurate enough for routine work since the apparent blank varies twofold.

In order to save time it is highly desirable to eliminate the hydrogen-sulphide separation of the platinum. In order to maintain a fair degree of accuracy the pyrosulphate fusion must be omitted or it must be done so as not to introduce platinum.

III. Omission of Pyrosulphate Fusion

It is possible to stop the hydrofluoric and sulphuric acid evaporation before the acid has been completely expelled. All of the residue is then soluble in dilute hydrochloric acid so that the titration can be made using this solution. Table II shows the results obtained by this method.

TABLE II

DETERMINATION OF Fe_2O_3 IN BUREAU OF STANDARDS SODA FELDSPAR NO. 99
OMITTING FUSION WITH PYROSULPHATE (ALL SAMPLES 5 GRAMS)

No.	Fe_2O_3 in sample (gram)	Fe_2O_3 found (gram)	Difference (gram)[a]	Per cent corrected by av. difference	Error (%)
1	0.00325	0.0045	0.00125	0.076	+0.011
2	"	0.0040	0.00075	0.066	+0.001
3	"	0.0036	0.00035	0.058	−0.007
4	"	0.0036	0.00035	0.058	−0.007
5	"	0.0040	0.00075	0.066	+0.001
6	"	0.0037	0.00045	0.060	−0.005
7[b]	None	0.0002	0.0002		
8[c]	0.0102	0.0104	0.0002		

[a] Average difference of feldspar results 0.00065 grams.
[b] Blank using reagents only.
[c] Twenty-five ml. standard ferric chloride solution.

The residues after the evaporation were always dark colored. Ignition of the sample failed to eliminate the trouble. The variable results are probably caused by the organic matter in the final solution. It is evident the method is not sufficiently accurate.

IV. Pyrosulphate Fusions in Silica

Vitreous silica crucibles have been recommended for pyrosulphate fusions. Their use should certainly eliminate any further platinum contamination, and the results would be expected to be of the same accuracy as the results obtained in sand analysis by the routine method. Table III shows the results obtained when the pyrosulphate fusion was made in a silica crucible.

TABLE III

DETERMINATION OF Fe_2O_3 IN BUREAU OF STANDARDS SODA FELDSPAR NO. 99
PYROSULPHATE FUSION MADE IN SILICA

No.	Fe_2O_3 in sample (gram)	Fe_2O_3 found (gram)	Difference (gram)[a]	Per cent corrected by av. difference	Error (%)
1	0.0065	0.0071	0.00060	0.066	+0.001
2	0.00325	0.0037	0.00045	0.065	0.000
3	"	0.0036	0.00035	0.063	−0.002
4	"	0.0037	0.00045	0.065	0.000
5	"	0.0037	0.00045	0.065	0.000
6[b]	None	0.0004	0.0004		
7[c]	0.0102	0.0106	0.0004		

[a] Average difference of feldspar analysis 0.00045 gram.
[b] Reagents only.
[c] Twenty-five ml. of standard ferric chloride solution.

All of the corrected results are in excellent agreement with the standard value of 0.065% Fe_2O_3. The blank is small as compared with those of the other methods, and it is constant. This was the only series in which the blank with reagents or a pure solution agreed with the actual analysis.

The silica crucibles were 200 ml. capacity and especially recommended for pyrosulphate fusion. After ten fusions they showed very little sign of attack. If the melt is kept at a sufficiently low temperature there should be but little solution of the silica.

In all three series of analyses the quantities of reagents were controlled. The pyrosulphate was weighed roughly and the volumes of hydrofluoric and sulphuric acids were measured.

All titrations were made with the solution hot and were carried out as rapidly as possible. The standard dichromate solution was added from a burette in 0.5 ml. portions near the end points. The e.m.f. changes were measured with a Leeds and Northrup electrometric indicator.

As a further check on the method the iron was determined in four samples of Bureau of Standards glass sand No. 81. In two of the samples the resi-

due was fused with sodium carbonate and in the other two with potassium pyrosulphate (Table IV).

TABLE IV

ROUTINE ANALYSIS OF BUREAU OF STANDARDS GLASS SAND NO. 81

Wt. of sample (grams)	Fe_2O_3 present (%)	Fe_2O_3 found (%)	Error (%)	Residue fused with
5	0.0724	0.074	+0.0016	Na_2CO_3
10	0.0724	0.072	−0.0004	Na_2CO_3
5	0.0724	0.073	+0.0006	$K_2S_2O_7$
10	0.0724	0.072	−0.0004	$K_2S_2O_7$

The accuracy is well within the limits expected and the results seem to show that routine analyses can be accurate.

V. Summary

(1) Pyrosulphate fusions in platinum introduce a variable amount of platinum.

(2) Omission of pyrosulphate fusions gives high results due to presence of organic matter.

(3) Pyrosulphate fusions in vitreous silica eliminate the necessity, in routine analysis, for the removal of platinum with hydrogen sulphide. Sufficient accuracy is maintained and the time required is reduced one half.

HAZEL-ATLAS GLASS COMPANY
WASHINGTON, PA.

A MECHANISM OF BLACK SPECK FORMATION IN ENAMEL RESULTING FROM REBOILING OF THE GROUND COAT*

By Anson Hayes, J. J. Canfield, and G. W. McGohan

ABSTRACT

Experimental and microscopic evidence is given to show that reboiling of a ground coat results from a fracture when refiring the ground-coat enamel. Air fills the cracks and connected bubbles. The cracks are sealed over and there is an expansion of the bubbles downward toward the base metal into the oxide layer. No evidence has been found which indicates that reboiling is caused by evolution of gas from the metal.

I. Introduction

Among enamel defects are black specks which have usually been considered unavoidable.

There are many causes of black specks: (1) reboiling of the ground coat, (2) fishscaling or jumpers, (3) copperheads, and (4) dirt or impurities. Those resulting from fishscaling, copperheads, and dirt may easily be prevented but it is difficult to avoid black specks resulting from reboiling the ground coat.

The object of the paper is to describe a probable mechanism for reboiling. The mechanism is believed to be one of major importance, but may not be the only mechanism.

(1) Reboiling Schaal and Fuller[1] have shown that one cause of black specks is the formation of large bubbles in the ground coat during the second firing. They concluded that these bubbles were caused by the evolution of gas from the metal. This, however, is not a satisfactory explanation. Experimental evidence does not indicate that gas evolution from the metal is the chief cause of large bubbles in the ground coat.

This formation of large bubbles has been called "reboiling," "secondary boiling," and less aptly "black specking." It is characterized by raised spots formed upon refiring the ground coat. If the sample is removed from the furnace as soon as the raised spots appear, the ground coat will exhibit the appearance of a boiled surface. These raised spots will show through a white coat causing black specks which cannot be hidden even by several applications of cover coats, for the ground coat will reboil on each successive firing.

A test for the tendency of a ground coat to reboil is made by replacing a ground coat enameled piece in a furnace at 1500 to 1600°F and retaining it in the furnace for thirty seconds to one minute. If reboiling occurs, raised spots develop during this reheating.

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* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Enamel Division).

[1] R. B. Schaal and D. H. Fuller, "Modern Enameling Troubles," *Ceram. Ind.*, 15 [6], 605–14 (1930).

II. Mechanism of Reboiling

A series of minute fractures occur in the enamel coat just before the reboiling. These fractures lead to the surface of the enamel and from bubble to bubble, drawing in air. Subsequently the cracks seal at the surface with rising temperature, and later the smaller bubbles coalesce into larger bubbles near the metal base.

These cracks result from stresses in the enamel which are controlled by such conditions as rapid cooling or heating, the enamel strength, oxidation of the metal, and processing condition. The essential feature of this theory of the cause of reboiling is that such stresses lead to the formation of the cracks which induce air-filled bubbles. During firing the bubbles expand and produce the rough "reboiled" surface or break and produce black specks in cover coats.

(1) Temperature of Reboiling To determine the temperatures at which the phenomenon of reboiling occurs, thermocouples were spot-welded to metal samples, which were cleaned and enameled with a ground coat. After cooling, the reboiling test was made at different temperatures.

The temperatures at which the blisters began to rise were 1000 to 1200°F. When tested for reboiling with the furnace at 1300 to 1400°F the samples heated more slowly than with the furnace at 1500 to 1600°F. This slower heating rate facilitated the more exact determination of the temperatures at which the reboiling bubbles began to form. The temperature at which boiling begins is found to be 1110 to 1135°F.

(2) Effect of Rate of Heating A slow heating rate through the range of 1000 to 1350°F will prevent the formation of bubbles. Ground coats which readily reboil when heated in a furnace held at 1500°F will not blister if heated slowly through their softening temperature range.

Test pieces placed in a furnace held at 1800°F showed more severe blistering than those which were reheated at lower temperatures. Some pieces which did not show reboiling at 1500°F, boiled when heated at 1800°F.

(3) Behavior of Samples When Enameled on One or Both Sides Many ground coats reboiled when fused on both sides of the test piece but did not when fused on one side only. If the unfired enamel be removed either totally or in any desired design from one side of the sample before the first firing, on reheating boiling will not occur opposite the places where the unfired enamel was removed, but if the fired enamel is ground off the back of the sample after the original firing and before the reboiling test, reboiling will occur.

(4) Effect of Size of Enamel Particles Coarse enamel prevents large bubbles. Ground coats milled to 0.6 and 34% residue on 200-mesh showed lesser reboiling with the coarser enamel. Ordinary enamel mill practice produces ground coats much finer than 34% residue on 200-mesh. Fineness of grinding in ordinary mill practice has little to do with the cause or prevention of reboiling.

(5) Effect of Annealing of the Metal The tendency to reboil is not removed by annealing the metal prior to enameling. Samples of metal heated at 1400°F for an hour under a vacuum of approximately 2 centimeters mercury pressure were subsequently enameled with ground coats. Ground coats on annealed metal showed the same reboiling tendencies as on the unannealed metal. This was true whether or not the metal pieces were pickled in acid before the original firing of the ground coat.

In another annealing experiment, metal samples were cleaned, dipped in the enamel slip, dried, and then annealed for various lengths of time (ten seconds to one hour) at temperatures of 1200°F and 1400°F. These samples were immediately fired at 1600°F after their removal from the annealing furnace. After cooling and testing for reboiling, no decrease in reboiling tendency could be noted.

(6) Effect of Metal Thickness Sheet samples of gages 18, 20, 22, 24, and 26, each having had the same rolling mill treatment, were enameled and tested for reboiling. Although tests on the 26-gage material showed no reboiling, some appeared on the 18-gage material. As the gage thickness was decreased, the tendency toward reboiling also decreased.

(7) Effect of Difference in Metal Different lots of metal show different tendencies toward reboiling of the ground coat, but no metal has been found on which reboiling will not occur. For instance, when the original firing is made at 1800°F to approximate the same appearance of a longer firing at 1600°F, reboiling occurs on refiring. Enameled pieces which do not readily show reboiling when the original firing has been made in a large box-type electric furnace, have been found to show reboiling if the original firing was made at 1600°F in a small laboratory muffle furnace.

(8) Effect of Length of Firing Time Many samples when originally fired for four or five minutes at 1600°F did not reboil unless fired for two minutes longer. If samples which show reboiling are left in the reboiling test furnace until the blisters have subsided, then cooled, and repeatedly refired as originally through the softening range of the ground coat, they will reboil for a number of times.

(9) Effect of Potential Gas Content in the Metal

A few gas analyses of different steels by vacuum fusion in the apparatus described by Vacher and Jordan[2] showed that there was little difference in gas content of the steels but that the product of carbon and oxygen was greater on these samples which did not show reboiling. It is difficult to see any correlation between the result of gas analyses and the presence or absence of reboiling.

FIG. 1.—500 ×.

III. Relation of Cracking and Reboiling

Cracks were found in all ground coats that reboiled. Ground coats which reboil will not develop cracks when heated in a reboiling test for a time period much shorter than that required to cause reboiling. Cracks do develop, however, just before reboiling begins. Figure 1 shows a crack extending from the surface into a bubble. The light area is the base metal and the darkest area is the ground coat. The hazy layer in the enamel is caused by iron oxide. Microphotographs of other ground coats show cracks where reboiling is beginning. Samples which do not show reboiling do not have these cracks.

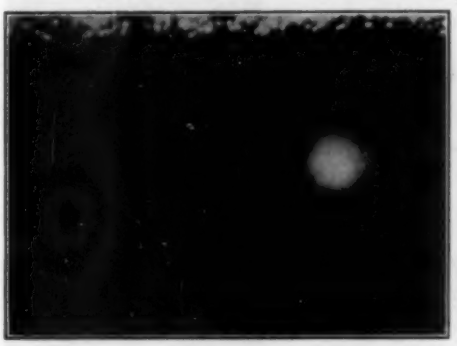

FIG. 2.—500 ×.

Ground coats fractured by water- or air-quenching will reboil in the reboil test. Figure 2 is a typical microphotograph showing fractures produced by water-quenching of ground coats which normally would not reboil. When samples were water-quenched after a shorter heating time in a furnace at 1500°F, cracks were not produced and no reboiling occurred.

In reboiling the first step to the formation of large bubbles is the development of a microscopic fracture. The stages of bubble formation are shown in Fig. 3. Figure 3 is a bubble which is touching the iron oxide layer and beginning to expand downward toward the base metal. Figure 4

[2] H. C. Vacher and Louis Jordan, "The Determination of Oxygen and Nitrogen in Irons and Steels by the Vacuum-Fusion Method," Bur. Stand., *Jour. Research*, **7** [2], 375–401 (1931).

shows a large, fully expanded bubble lying near the base metal.[3] After the bubbles have expanded, the cracks disappear almost completely from the enamel. Figure 5 shows several bubbles connected by cracks.

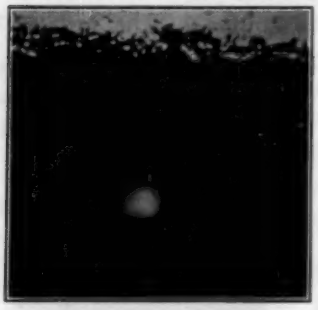

FIG. 3.—500 ×.

IV. Discussion

Reboiling of the ground coat results from stresses which cause fractures in the enamel. These fractures and the consequent bubbles are filled with air.

Heating causes the top portion of the crack to seal when the enamel reaches the softening range. The smaller bubbles coalesce into larger bubbles near the base metal. These larger bubbles are enormous when compared to those normally existing in the enamel and are caused by several bubbles feeding through cracks into the one expanding.

It is possible to produce the reboiling tendency by water-quenching of samples that ordinarily do not reboil. No evidence has been found contradictory to the conception that reboiling results from a stress great enough to cause a fracture of the enamel. The fact that reboiling may be prevented by slow heating means that the temperature gradient is such that stresses are not great enough to cause fracture.

Sufficient stress formation in the enamel during the original firing and cooling causes fractures in the enamel and reboiling. As a result of such stresses, samples enameled on only one side do not reboil, whereas samples enameled on both sides show reboiling. Also grinding the enamel from the back side after this original firing does not entirely relieve stresses developed in cooling and does not prevent reboiling.

FIG. 4.—500 ×.

Stresses in the ground coat explain why the samples will repeatedly reboil.

Stresses in the enamel can be great enough to cause fractures of the enamel even though the metal be annealed in a vacuum.

The fact that reboiling may be produced by quenching ground coats which ordinarily have no reboiling tendencies seems to confirm this theory of the mechanism of reboiling.

[3] This bubble is filled with polishing material and therefore appears slightly different from the other bubbles.

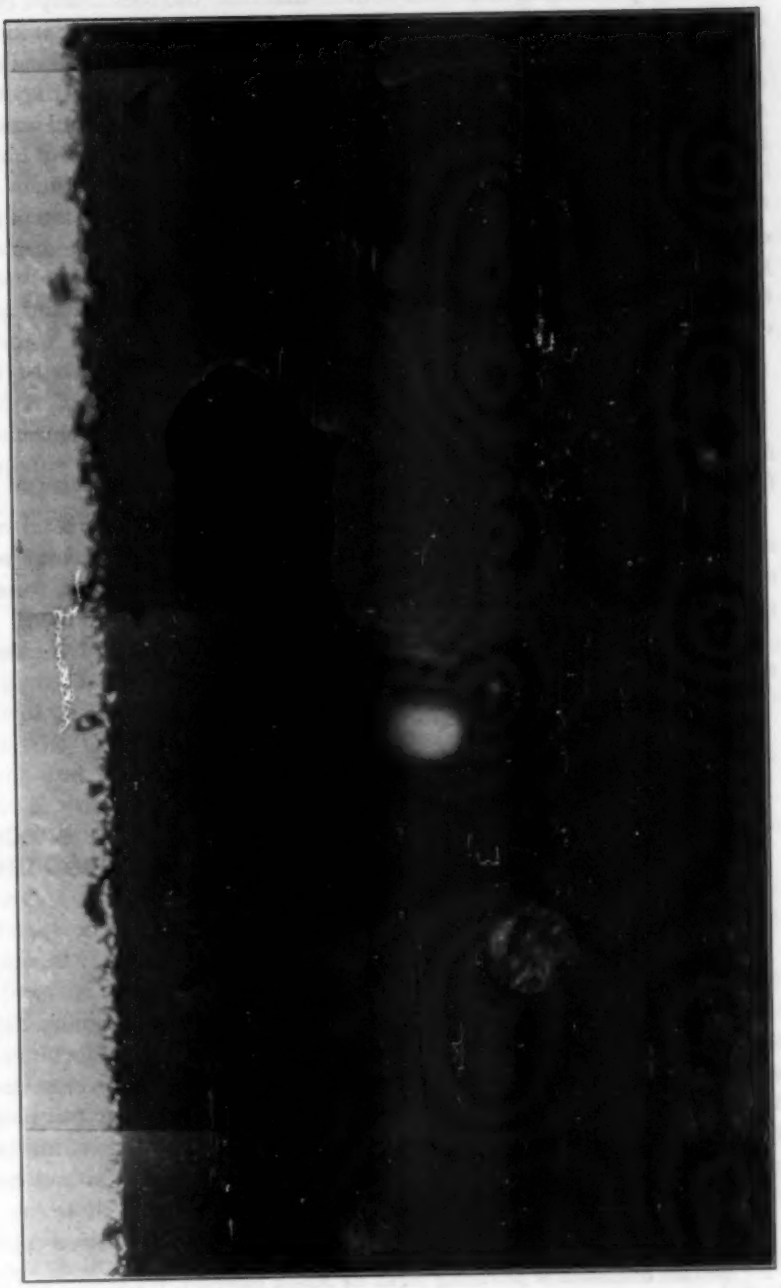

FIG. 5.—500 ×.

Microscopic examination has shown that the bubbles always expand downward into the iron oxide layer. It has been found that iron oxide lowers the softening point of an enamel and it is believed that the viscosity of this layer is much lower than that of the outer layer. Rust spots will cause dark spots in a ground-coat enamel when present in small amounts. Microscopic examination of these spots shows that they are free of bubbles. This is evidence that the viscosity of enamel containing iron oxide is lower than the iron oxide free enamel. It is also true that examination of many enameled specimens has shown that bubbles rarely occur in the iron oxide layer of a normally fired ground coat. The reboiling bubble invariably touches the iron oxide layer at the beginning of the expansion and always expands downward into the iron oxide layer.

V. Summary

A mechanism for the formation of black specks in enamels from reboiling of the ground coat has been shown to be a fracture with the subsequent formation of large bubbles in the enamel glass.

No evidence has been found that gas evolution from the metal causes reboiling. A consideration of all the experimental evidence and microscopic examinations leads to the conclusion that gas evolved from the metal is not a major cause of reboiling.

The prevention of reboiling will depend on the control of the factors which produce the stresses in the enamel coat.

American Rolling Mill Co.
Middletown, Ohio

DISCUSSION* ON "A MECHANISM OF BLACK SPECK FORMATION IN ENAMEL RESULTING FROM REBOILING OF THE GROUND COAT"

By Robert B. Schaal and Donald H. Fuller

I. Introduction

The paper by Hayes, Canfield, and McGohan represents many days of diligent research and hard work. The dollars and cents importance of a definite solution of the whole subject of boiling cannot be overestimated. With the accomplishment of this solution all major enameling troubles will be solved and will soon be cured with the exception, of course, of individual problems introduced by design or other peculiarities inherent in each manufactured article.

It is the purpose of this discussion to give ideas and conclusions concern-

* Written discussion of preceding paper by Anson Hayes, J. J. Canfield, and G. W. McGohan.

ing the actual function of the cracks in question in relation to the boiling phenomenon, to explain why the cracks occur on iron which boils and are absent on iron which does not boil and to present certain additional experimental data and evidence in support of the ideas advanced herein. In the course of this discussion we shall try to account for the experiments performed by the authors on the theory that gas is evolved from or generated in the iron base or in a reaction occurring by reason of the enamel being applied on certain iron as opposed to its application on an inert material such as porcelain.

No attempt is made to give an exact or definite mechanism for the generation or evolution of this gas, but the evidence points so strongly to the presence of some gas other than entrapped air that the authors feel compelled to reiterate this idea and call attention to the reasoning and evidence in its support.

II. Physical Effects of Heating an Enameled Piece

The kinds and relative magnitudes of the stresses induced into the enamel layer by reheating at an elevated temperature in relation to the time during which the piece is in the furnace will be developed first. In other words, the expansion rates of both the iron and the enamel against time will be shown (Fig. 1). The areas or the perpendicular distance between the curves will indicate the relative direction and magnitude of the stresses introduced.

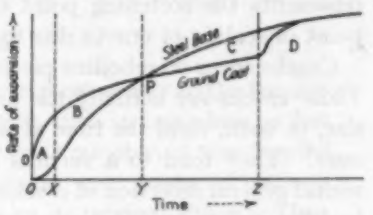

FIG. 1.—Representation of reheating stresses in fired ground coat.

A, increasing compressive stress during time, *OX*. *B*, diminishing compressive stress during time, *XY*. *P*, point of no stress at time, *Y*. *C*, increasing tensile stress during time, *YZ*. *D*, diminishing tensile stress during incipient melting.

The curves in Fig. 1 are not quantitative but vary with the variation of any factor on which they are predicated. These curves simply represent the general trend.

Before the fired ground-coated piece is placed in the hot furnace the enamel layer is under a certain degree of compression, indicated on the diagram by the line *O–O*. The expansion rate is zero but it is necessary to make the representation in this way to indicate that a stress is present at this point. When the piece is introduced into the hot furnace, the heat first strikes the surface of the enamel and causes it to expand more rapidly than the steel which is temporarily protected by the enamel layer. The time necessary for the first period of increasing compressive stress is represented by the distance, *O–X*. This time, *O–X*, is a time of increasing compressive stress, and is evidenced in practice by a tendency of the enamel to fishscale and fly off in small chips.

After passing the time, X, the heat penetrating through to the iron begins to have a greater effect and the steel begins to catch up with the expansion of the enamel, resulting in a time, $X-Y$, of decreasing compressive stress. During this period of the heating, stresses are relieved and no notable effects are produced in the enamel layer.

At a certain time, Y, the expansion of the iron base overtakes the expansion of the enamel and produces a point, P, at which there is probably neither a compressive nor a tensile stress. That this point occurs and that the expansion of the base overtakes the expansion of the enamel is evidenced by observation of enameled pieces while cooling and is too plain to be mistaken.

At a time, $Y-Z$, during which the enamel is under an increasing tension, Z represents the softening point or range of the enamel and probably the point of sealing of cracks due to surface softening.

Cracks occur on reboiling pieces just before the softening point is reached. These cracks are actually the product of tension and increase in number, size, or both, until the time at which the surface softens and begins to seal over. They tend to a vertical direction, as opposed to the curved horizontal general direction of cracks produced by compression, and can readily be imagined to penetrate deeply into the enamel layer, even down to the base.

III. Explanation of Observations

If cracks can introduce air or gas from the surface to the interior they can also aid in its escape or, in other words, permit the easy passage of gas from the base to the surface of the enamel.

(1) Why Slow Heating Tends to Relieve Reboiling

If the heating up proceeds slowly, the point, P, on the diagram is relatively displaced to the left. The line, Z, is relatively displaced to the right. The time during which tension cracks can be produced is greatly lengthened and at the same time the distance between the curves is undoubtedly increased, thus increasing the magnitude of the tensile stress. More cracks can be produced, more gas can escape before the surface liquefies, and the tendency is for more nearly simultaneous liquefaction of the whole enamel mass instead of prior surface liquefaction.

(2) Why Magnitude of Boiling Is Greater with Soft than with Hard Ground Coats

In the normal heating, since soft ground coats usually have higher expansion coefficients, the point, P, is displaced to the right. Because they soften much earlier, the line, Z, is displaced definitely to the left. The region during which cracking from tension occurs is both shortened and dimin-

ished in magnitude in regard to stress. Soft ground coats afford much less opportunity for the escape of gas than hard ground coats.

(3) Why Reboiling Is Less Violent on Pieces Enameled on One Side Only

In this case it is unnecessary for heat to penetrate the ground coat to reach the steel. This fact, of course, displaces the point, *P*, far to the left, and enormously increases the tension stresses and the time over which they occur.

If the gas evolution theory is at all tenable, the effect of the production of cracks must be to relieve reboiling on the violently boiling iron, while on the nonboiling iron the introduction of cracks should produce a certain limited boiling effect due to expansion of entrapped air. It should, otherwise expressed, tend to reduce the boiling on the different classes of steel to uniformity.

IV. Experimental

To produce cracks in the enamel to correspond most nearly to the tension cracks which are hypothecated and at the same time to introduce as few complications in the way of heating and cooling as possible, it was decided to bend the fired, ground-coated piece until cracks were produced on both front and back, and then to restore the piece to its original shape. Thus on the front, tension cracks, and on the back, both tension and compression cracks were produced. This was done with several ground coats on both boiling and nonboiling iron. The pieces were reheated with the furnace at 1500°F in the usual manner.

Reboiling was relieved over the cracked areas of the reboiling pieces while on the nonboiling pieces the effect of the entrapped air alone was distinctly shown with its relative magnitude. The cracked areas on both the steels have nearly the same appearance, while the natural boiling has not been interfered with over the remainder of the pieces. This is the case on both the front and back.

The pieces were further enameled with white. The cracked areas covered up just as well as the noncracked parts of the pieces in spite of the multiplicity of cracks artificially produced.

V. Effects of Quenching

Hayes, Canfield, and McGohan produced artificial cracks by quenching. It is believed that this evidence is not germane to the matter in hand since it introduces (*a*) the effects of rapid cooling which are not consistent with usual practice, (*b*) the fact that the cracks observed in connection with boiling are not present before reheating, and (*c*) possibly other factors which affect the state of the base metal. The effect of cracks induced by quenching, however, was studied.

Pieces were prepared of boiling and nonboiling iron fired in ground coats

in the usual manner. With the furnace held at 1500°F these pieces were introduced into it for different lengths of time, from 5 to 25 seconds. They were then removed and immediately half the length of the piece was dipped in water and quickly removed. The pieces were prepared in duplicate. One of each pair was set aside and the other reheated in the usual manner. The result of this treatment produced some phenomena evidently not noticed by the authors of the paper under discussion.

On placing the pieces in the furnace several large bubbles appeared almost immediately upon the quenched end near the edge. These bubbles continued to appear a few at a time over the entire reheating period and the area covered by them gradually spread.

At the usual time of reboiling, the ordinary reboiling phenomenon appeared upon the unquenched end of the piece, and simultaneously a fine boiling appeared over the entire quenched half of the piece.

The significance of this apparent double boiling on the quenched area can only be explained by the theory that two distinct causes are present. When the pieces are withdrawn from the furnace the entire quenched half is covered with a fine boiling which looks like the expansion of air in cracks in addition to a few relatively enormous bubbles which are much greater in magnitude than those produced in the area of the piece which reboiled in the normal way. It appears that quenching introduces factors other than the actual shattering of the surface of the enameled piece. This should be the subject of further investigation.

VI. Effect of Annealing

Hayes, Canfield, and McGohan state that annealing and combined evacuation and annealing before firing the ground coat do not relieve reboiling. It would seem more pertinent if the annealing were done after the ground coat is fired. With this in mind pieces were annealed which had been quenched and set aside as before for 12 hours at 850°F. On refiring, the boiling pieces did not boil and the quenched ends did not boil badly.

Supposedly there were just as many cracks present after the annealing as before, since the annealing was conducted below the softening point of the enamel in question. This matter also is worthy of further investigation.

VII. Boiling Produced by Expansion of Entrapped Air

Several references have previously been made as to the probable magnitude of the boiling which could be expected from the connection of bubbles by cracks and the expansion during heating of the entrapped air. To form a basis for a possible calculation a piece of 20-gage steel weighing 50 grams, size $2^1/_2$ by 4 inches, enameled in ground coat, and reboiled in the usual

manner was selected. This piece represented a good average condition of reboiling. A careful examination of cross-sections revealed that the average small bubble had a diameter of about one-fifth the depth of the enamel film. The diameter of an average reboiling bubble or large bubble is approximately twice that of the thickness of the enamel film. The diameter of the average large bubble is therefore ten times the diameter of the average small bubble.

With these data the problem may be stated as follows: Assuming that the large bubble is due to the "expansion overflow" of many small bubbles, how many small bubbles will produce one large bubble?

The expansion of the entrapped air probably takes place from the temperature at which the crack seals to the temperature at which the bubble bursts. This temperature difference, as nearly as can be observed, is about 200° from 900 to 1100°F. In this temperature range, disregarding pressure, air will expand one-seventh of its volume at 900°. In other words, taking the diameter of the small bubble as our basis, the volume expansion is represented as $0.075d^3$. The volume of the large bubble is $523d^3$. It is therefore necessary to connect by cracks more than 7000 small bubbles to produce one large reboiling bubble. The average number of bubbles situated vertically in the enamel layer of this piece is 3. It would be necessary to connect every bubble in an area of 2300 small bubbles which is an impossibility.

Considering that the large bubble is composed by the coalescence of small bubbles, a somewhat different picture is obtained. It takes only 146 small bubbles to produce a large one. The difficulty in regard to the coalescence of these bubbles is the fact that during the 200° of expansion the order of diminution of bubbles is not nearly that great. For instance, in the case under consideration, the idea presupposes the existence in the piece at 1100°F of only $^1/_{146}$ as many bubbles as at 900°. This is easily shown to be entirely without foundation by inspection of a piece so treated under the microscope. Furthermore, the coalescence of these bubbles must take place in a very limited time, another great improbability in a viscous substance.

The evidence points to the probability of an expansion of about one-seventh of the volume of the entrapped air, as stated in the problem above, and many cases of reboiling indicate that the actual volume of the resultant bubbles is many times this amount. The indications are that expansion of entrapped air is inadequate to produce the effects noted.

VIII. Amounts of Gas Generated from the Metal Base Sufficient to Produce the Observed Boiling

On the piece just described the best possible count reflects the presence of 2000 reboiling bubbles of a diameter of 0.2 mm. The volume at 0°C

of these bubbles (collectively) is 2.59 mm.,[3] corrected from the volume produced at 1100°F. The metal contains 0.02% C.

If 22,400,000 mm.[3] of CO_2 weigh 44 grams at 0°C, then 2.59 mm.[3] weigh 0.000005104 gram. On the 50-gram piece this is equivalent to 0.0000028% C. Obviously, the determination of this small amount of carbon is impossible.

Accepting the analysis of Hayes, Canfield, and McGohan of 0.0008% hydrogen, there is present 1700 times enough to cause the reboiling. The same calculation may be applied to any of the other elements determined by them.

To determine the possibility of carbon, even in the state of graphite, producing a reaction at the temperatures involved in the production of reboiling, a small amount of pure graphite was rubbed into the surface of a piece of enameling iron which was dipped, dried, fired, and reboiled. A violent reaction took place.

IX. The Probable Cause of Cracks in Reboiling Steel before Softening and the Relation between Primary Boiling, Copperheading, Certain Types of Fishscale, and Secondary Boiling

Ground coats which possess copperheading tendencies exhibit them on reboiling steel. There is no copperheading on steel which will not reboil in ordinary treatment.

Where secondary boiling or copperheading occurs, primary boiling also occurs. On all pieces exhibited here, regardless of ground coat or firing time, no fishscale was apparent on the nonboiling steel after one year regardless of the length of firing or of the ground coat. On all pieces which reboiled or which would reboil, there was primary boiling, copperheading (dependent on the ground coat), and fishscaling.

On pieces where there is no primary boiling there is also no copperheading, no fishscaling, and no secondary boiling. Hundreds of samples have confirmed this idea, and so far no inconsistencies have been observed.

It has been shown previously[1] that on boiling, the passage from the steel of abnormal amounts of gas through a ground coat largely increased the number of bubbles retained when the piece was cooled after firing, causing "swelling" of the ground coat. This kind of film is weak, and to this weakness is ascribed the ready tendency to fishscale. This same weakness of the ground coat in the case of boiling steel will account for the production of the cracks in the ground coat during heating and just before fusion takes place.

In addition to the physical derangement and augmentation of the bubble structure of the ground-coat film, the passage of gas in this case also seems

[1] See footnote 1, p. 338.

to carry up amounts of iron oxide from the base which are irregularly distributed in the enamel, thus affecting the uniformity of expansion of its adjacent areas. There is the further possibility of a direct increase in viscosity of the liquid enamel film at high temperatures from the reaction of the passing gas, and thus the retention of larger, more irregular bubbles and larger quantities of them in the ground coat. Microscopic evidence supports all these contentions.

X. Summary

The probable physical action of the ground coat and the mechanism of crack production upon reheating a piece of enameled steel at 1500°F are explained with supporting data.

The effects of quenching and annealing are explained and new pertinent data concerning the effects of these treatments are given.

The inadequacy of the crack and air-expansion theory is demonstrated as is the adequacy of the gas theory to the case in point from a semiquantitative point of view.

Evidence is presented that there is a decided relation between primary boiling, copperheading, fishscaling, and secondary boiling, and the formation of heating cracks in boiling steel compared with the absence of cracks on nonboiling steel is explained.

XI. Conclusions

From the ideas presented, the confirming data, and previous experiments, the following conclusions are drawn:

(1) The crack theory is inadequate to explain entirely the character of reboiling.

(2) Gas generating elements are present in amounts adequate to the formation of reboiling.

(3) While the production of cracks has an influence which explains some inconsistencies in behavior, it really supports the theory of gas evolution rather than discredits it.

(4) From the evidence, there is a direct relation between primary boiling, copperheading, fishscaling, and secondary or reboiling.

ROBERTS AND MANDER STOVE COMPANY
HATBORO, PA.

AUTHORS' REPLY TO DISCUSSION OF SCHAAL AND FULLER*

The discussion of F. B. Schaal and D. H. Fuller is stimulating to the authors of this paper. Since the authors recognize that the experimental data are incomplete on certain phases of the phenomenon of reboil, the summary of the experimental behaviors which have been obtained will be

* Received April 28, 1932.

stated here. Further statements will be withheld until more critical experimental data are available. The evidence which has been interpreted as indicating the important part which stresses sufficient to fracture an enamel play consists of the following points:

(1) Light-gage material is essentially free from reboiling no matter what lot of enamel stock is tested.

(2) The heavier gages of the same stock from which non-reboil light-gage stock is made, if coming from stock subject to reboil, show more pronounced reboiling as the thickness of the metal is increased.

(3) Sheets which reboil when regularly enameled may be enameled so as not to reboil (1) by slow cooling from the ground-coat firing temperature, (2) by normal rates of cooling from the ground-coat firing temperature followed by a slow rate of heating in the second-coat firing temperature, or (3) by properly reducing both the cooling rate from the ground-coat firing temperature and the heating rate to the second firing temperature.

(4) Samples of metal which normally reboil when the ground coat has been applied to both sides show almost complete freedom from reboiling if enameled on only one side.

(5) Reboiling occurs on pieces during the first test for reboiling after the removal of the fused ground coat from one side at room temperature. Subsequent heatings thereafter show no further reboil, as is true of the pieces which had ground coat applied to one side only.

(6) Stock which normally reboils when enameled on both sides in the ground coat also reboils if enameled on one side only, but with the base metal protected with asbestos paper during the cooling period from the ground-coat firing temperature.

(7) Metal which reboils when enameled in ground coat in the usual manner does not reboil if not allowed to cool below a temperature of approximately 500°F before reheating in the reboil test.

(8) A sheet of metal which is normally free from reboil will show reboiling on the portions subjected to tension when the sheet is subjected to a slight drawing operation. The size of bubbles, their number, and general appearance are comparable to those found in badly reboiling stock on such portions of the drawn sample as were subjected to multi-directional tensional stresses in the drawing operation.

It seems impossible to discuss the ranges of temperature over which compressional or tensional stresses may exist in the enamel, until quantitative data are available on coefficients of expansion of the enamel over all ranges of temperature for which the enamel is essentially rigid, and also data showing temperature differences which develop between the base metal and the enamel, particularly at the time that the enamel has just become rigid on the cooling cycle, and, more generally, what temperature differences are developed on the reheating cycle.

Since the presentation of the present paper at the Washington meeting, attention has been called to the work by R. Weinig.[1] This information indicates a great increase in the coefficient of expansion of the enamel at temperatures near and slightly below the softening temperature. This would indicate that there probably is a tensional stress developed during the period the enamel is cooling through this temperature-interval. As is well known, this tensional stress is changed to compressional stress on further cooling to room temperature by the leveling of temperatures of the enamel and metal. Upon reheating, however, since the temperature of the

[1] R. Weinig, *Sprechsaal*, **63** [38], 723 (1930); reprinted in *Ceram. Ind.*, **18** [4], 250 (1932).

enamel leads that of the base metal, tensional stresses during the heating cycle are much less likely to occur. The probability of their occurring is further lessened by the larger coefficients of expansion of the enamel near the softening temperature. Whether or not the stresses in the enamel become tensional in these temperature intervals near the enamel softening range, the authors do not know.

The authors understand that Mr. Schaal is proceeding with experimental work which will result in a much more exact knowledge of these expansion behaviors as well as the differences in temperatures which are developed.

American Rolling Mill Co.
Middletown, Ohio

VITREOUS ENAMEL IMPACT MACHINE*

By H. H. Holscher

ABSTRACT

A description of and data obtained with a pendulum type impact machine developed especially for use on intricately shaped electric range parts are given. The machine has been designed in such a manner that it reduces the personal factor of operation to a minimum. The effect of enamel and steel thickness upon impact is presented.

I. Introduction

Porcelain enamels applied to sheet steel must have sufficient adherence to withstand normal handling and, in some cases, considerable rough treatment. As a measure of adherence and chipping tendency various types of impact machines have been used. This paper presents a description of a pendulum type impact machine and results obtained with its use.

With this machine large and intricately shaped enameled pieces, such as range parts, may be easily tested. The personal factor of operation is reduced to a minimum.

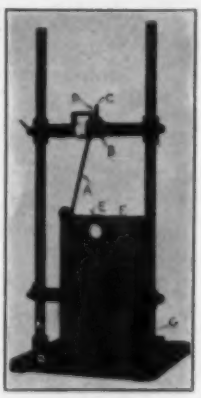

Fig. 1.

II. Description of Machine

The main features of the machine are shown in Fig. 1. (1) The impact arm, *A*, swings on ball bearings and is adjustable from zero position up to an angle of 125°. (2) The roller, *B*, which carries the arm, *A*, carries notches which divide the 125° swing into 27 equal divisions. (3) The arm, *C*, held by a spring, *D*, engages these various

* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Enamel Division). Received January 26, 1932.

notches and holds the pendulum hammer at any desired angle. (4) A scale calibrated in inch-pounds gives the reading for each position. (5) The head of the hammer is circular with a 1-inch radius and strikes directly over the center of the back support piece which also is circular ($1^1/_4$ inches in diameter) and which has a hole $^3/_4$ inch in diameter. (6) The test panel is held in place against the back support piece by means of the large ring, *E*, pivoted on the arm, *F*, and is pressed against the panel by the compression of spring, *G*. (7) The ring is faced with felt which prohibits scratching of the enamel and gives a firm, uniform pressure.

It is necessary that the panel to be tested rests firmly against the back support; if it does not, the force of the impact against the panel is lessened. The clearance of the back support piece from the large back plate permits intricate shapes to be placed in the machine.

III. Calibration of Machine

Knowing the center of gravity of the arm and hammer, experimentally determined, the angle through which it falls and its weight, and neglecting the friction, it was a simple matter to calibrate the machine. The calibration gives impact values from 0.04 to 20.2 inch-pounds.

IV. Accuracy of Impact

The accuracy of the actual blow given by the impact machine may be determined by measuring the depth of the depression formed when a plain sheet-steel test piece is used. The application of enamel introduces a rather indefinite factor with considerable difficulty in measuring the depth of depression.

As a means for determining the reproducibility of energy of impact on this machine, the depressions were measured on several sheets of 20-gage steel under the various graduated blows of the machine. As a method of comparison, similar results were obtained on ground-coated steel and on a thin cover-coated steel. In the case of the enameled test pieces, the depressions were made, then the enamel was removed, and the depressions were measured on the sheet steel. Depressions were measured by means of a micrometer screw mounted at the center of a three-legged support. The actual results obtained are given in Table I with the plus and minus deviations obtained. No measurements were discarded, the deviations being maximum in either a positive or negative direction.

A blow of 4.75 inch-pounds gave a depression of 0.0102 inch average with the maximum deviation being 0.0012 inch. This gives almost 12% deviation.

The extreme accuracy of measurement was 0.0004 inch so the maximum deviation is three times the accuracy of measurement, and is large enough to be rather definite in character. At the maximum impact of the ma-

chine, or 20.2 inch-pounds, the depression is 0.0409 inch with a deviation of 0.004 inch. This gives an error of less than 1%.

Apparently an error of from one to about 12% in the use of this machine due to variation within any one impact value may be expected. In the

TABLE I

ACCURACY OF IMPACT

Impact (in.-lb.)	Average Depression (inches) Plain steel	Deviation (±)	Ground-coated steel	Deviation (±)	Cover-coated steel	Deviation (±)
4.75	0.0102	0.0012				
5.58	0.0123	0.0016	0.0094	0.0008	0.0051	0.0004
6.45	0.0146	0.0008	0.0114	0.0016	0.0063	0.0016
7.37	0.0165	0.0012	0.0130	0.0004	0.0087	0.0004
8.33	0.0189	0.0012	0.0154	0.0004	0.0094	0.0004
9.33	0.0213	0.0012	0.0173	0.0012	0.0122	0.0008
10.3	0.0240	0.0024	0.0209	0.0008	0.0141	0.0000
11.3	0.0252	0.0016	0.0224	0.0012	0.0157	0.0012
12.4	0.0287	0.0020	0.0272	0.0012	0.0181	0.0008
13.4	0.0307	0.0008	0.0276	0.0012	0.0201	0.0004
14.5	0.0331	0.0012	0.0299	0.0012	0.0228	0.0012
15.5	0.0339	0.0008	0.0319	0.0020		
16.5	0.0350	0.0008	0.0327	0.0016		
17.5	0.0374	0.0008				
18.4	0.0382	0.0008				
19.3	0.0402	0.0004				
20.2	0.0409	0.0004				

range in which most sheet-steel enamels fail, *i.e.*, from 6.4 to 12.4 inch-pounds, an error of from 5 to 7% is to be expected.

The ground coat decreases the depression from 5 to 24%. In the case of the thin cover coat over the ground-coated steel a total decrease in deflection of from 31 to 56% is obtained. Necessarily the thin cover coat absorbed the difference, from 21 to 35% of the total deflection. It is also worthy of note that the deviations with a single cover coat were not materially greater than with steel alone.

It can be generally concluded that the actual impact blow of the machine from any definite setting is limited to rather narrow deviation.

TABLE II

RESULTS WITH A TYPICAL ENAMEL

Impact (in.-lb.)	No. of tests	No. of failures	Failures (%)
6.45	25	2	8
7.37	24	5	21
8.33	24	15	63
9.33	21	18	86
10.3	5	5	100

To test the above conclusion as to reliability of actual energy of impact a series of carefully prepared enameled panels was used. The per cent failures noted at various impact values are tabulated in Table II, a failure being

defined as the minimum single impact that gives a chipped surface at least $^1/_8$ inch in some dimensions which is easily rubbed out with the thumb nail.

Defining the point of failure as that point at which at least two-thirds of the tests fail, it is seen that the enamel tested has a failure of slightly more than 8.33 inch-pounds.

V. Effect of Enamel Thickness on Impact

The values of impact for various thicknesses of a standard enamel are tabulated in Table III. These values represent averages obtained on panels which did not vary more than six grams per square foot (about 0.001 inch thickness) from the average.

TABLE III

EFFECT OF ENAMEL THICKNESS ON IMPACT

Weight of application (grams/sq. ft.) cover coat	Total thickness	Impact (in.-lb.)
31.7	0.009	16.1
62.7	0.015	10.3
79.9	0.018	9.5

Twenty-gage metal was used in all the above tests. These results, plotted, would give a well-defined curve suitable for reference for the particular enamel used. Many enamels, however, give well-defined minimum impact values at a definite enamel thickness.

VI. Effect of Metal Thickness

The impact values for the same weight of enamel (66 to 67 grams per square foot or about 0.016 inch thick) applied on varying thicknesses of metal are tabulated in Table IV.

TABLE IV

EFFECT OF METAL THICKNESS

Metal thickness (in.)	Impact (in.-lb.)
0.125	40.4[a]
0.0375	10.0
0.0172	6.45[b]

[a] Two impacts at 20.2.

[b] Edge cracking failure due to bending of steel under impact. No chipping of enamel at all; concentric circular cracks.

These results show three distinct types of impact failure: (*a*) failure on heavy steel which is primarily crushing failure; (*b*) failure on the very light steel in which no chipping or crushing is noted and where failure is due only to the bending of the steel and subsequent cracking of the enamel; and (*c*) failure characterized by chipping on medium thickness metal.

VII. Conclusion

A vitreous enamel impact machine is described and its accuracy determined. Typical data obtained with the machine are given and show something of its usefulness.

The machine is especially applicable to routine testing of shop parts and to comparison between various sheet-steel enamels. By means of this machine a minimum standard of 7 inch-pounds has been set for enamel applied at 66 grams per square foot on 20-gage sheet steel.

Acknowledgment The writer wishes to acknowledge the work of F. R. Porter for the initial development of the impact machine.

EDISON GENERAL ELECTRIC APPLIANCE CO.
5600 WEST TAYLOR ST.
CHICAGO, ILL.

METHOD FOR THE STUDY OF THE RELATIVE VISCOSITY OF ENAMEL GLASSES[1]

BY C. J. KINZIE

ABSTRACT

A method has been developed by which the flow characteristics of vitreous enamel glasses may be conveniently studied. The apparatus and method are described. Typical results are illustrated both by photographs and by a chart based on planimeter measurements of area of flow.

I. Introduction

The apparatus and method described in this paper are the result of experimental studies of the flow of enamel glasses. The method consists of heating pellets of the enamel glass on a horizontally placed panel and for a sufficient period of time to cause a softening of the glass, and then by means of a suitable device to alter the position of the panel to the vertical position with the result that the enamel flows down the vertical surface. When the conditions as to the size of the pellet, duration of heating, and the temperature are constant, the properties of the enamel glass in the fused state can be ascertained.

In preparing the pellets, the powdered enamel glass (−60- +80-mesh) is mixed with paraffin wax on a brass plate at a temperature of about 75°C, using only enough paraffin to form a stiff mealy mix or one which will form pellets of sufficient strength to permit handling.

The warm mix is charged to the holes in the mold and firmly pressed with the plunger; more mix is charged and again pressed, continuing until the holes are full. It is then leveled with a straight-edge blade and removed from the mold by means of a plunger.

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Washington, D. C., February, 1932 (Enamel Division).

II. The Apparatus

The equipment consists of four parts: (1) An iron mold for forming the pellets. (2) Sheet-iron panels (16-gage), 6 by 4 inches, enameled in a ground coat, used to support the pellets. (3) A nickel-chrome alloy rack used to support the panel in a horizontal position is introduced to the furnace and equipped with a trigger support so that while in the furnace the panel may be lowered to hang vertically without opening the door of the furnace. (4) A simple centering device to insure the same position of equipment in the furnace for each test.

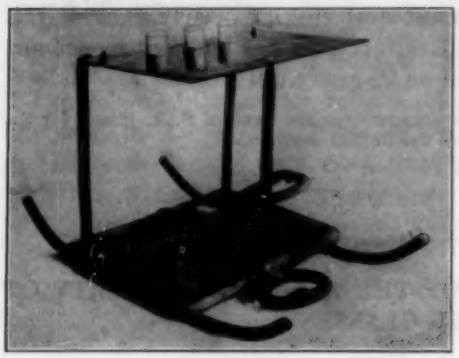

FIG. 1.

III. The Method

The pellets ($^1/_2$ inch diameter and 1 inch high) are placed in position on the panel which has been warmed just enough to allow the paraffin bond to soften at the base, and are then cooled to room temperature before using.

The panel rack is placed in the furnace and brought to the full furnace temperature at which the test is to be made.

The door of the furnace is raised and the rack is withdrawn. The panel carrying the pellets is placed on the three points and the rack is returned to position in the furnace and left in a horizontal position for three minutes. A small rod having a hook end is put through the peep hole in the furnace door and the trigger support is pulled, allowing the panel to assume a vertical position. It is left in this position for ten minutes. The panel is then removed and placed over a hot plate to prevent too rapid cooling.

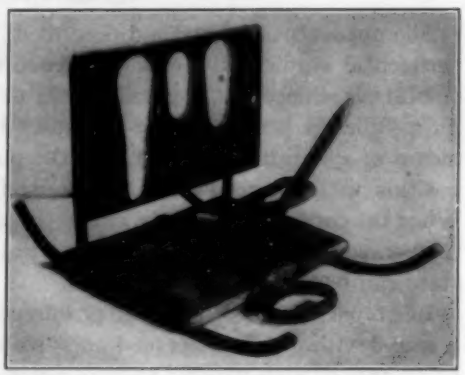

FIG. 2.

It is important to adhere rigidly to a definite cycle of operation using a stop-watch to time and control all operations including the removal of the rack, placing of the panel, replacing the rack, etc.

Figure 1 shows the rack with the pellet-bearing panel in place as it appears before placing in the furnace. Figure 2 presents the appearance of the rack and panel when removed from the furnace.

The furnace used in this work was an electrically heated automatic temperature control type, being readily adjustable for varied temperatures. The furnace chamber is 18 inches wide, 36 inches deep, and 12 inches high.

IV. Discussion of Results

Using the method as described, studies have been made of certain enamels over the full range from 1680°F down to 1200°F, at intervals of 40°F.

The results with three enamel glasses are shown in Fig. 3 to illustrate the possibilities of the method.

It so happens that in this group the enamel showing the greater flow at higher temperatures also proved to be softer in the lower temperature range; such is not always the case.

Although enamel "C" is more viscous than enamel "B," it reacts with the ground coat at 1680°, 1640°, and 1600°, whereas enamel "B," although spreading thin at the same temperature, still completely covers the ground coat. Some cover-coat glasses in this test react vigorously with the ground coat at higher temperatures showing the entire overflowed area a mass of white and ground-coat enamel intermingled in white and dark blotches.

There are enamels which will not spread as much as shown in "B," but which will flow as far down but in a narrower path.

It is seen that this method offers possibilities of some interesting studies of enamel glass properties.

Figure 4 shows curves plotted from planimeter measurements made for enamels "A," "B," and "C." Measurements were made only for those temperatures at which the pellets had spread out with the top in contact with the panel. If the top of the pellet was free from the panel no measurement was attempted.

FIG. 3.

V. Conclusions

This method brings out certain characteristics of enamel glasses which are imperfectly understood and which, if subjected to continued study, particularly by enamelers, should reveal many new aspects on enamel behavior.

The flow properties of fused enamel glasses sometimes indicate quite different properties than those which might be expected by softening behavior as shown in cone deformation point determinations.

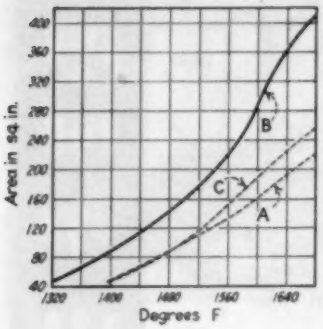

FIG. 4.

The method could readily be adapted to control work by using a smaller rack and a smaller panel to accommodate two pellets, a standard and a sample pellet. The matter of working with a smaller rack and panel should present no difficulties, and for control work tests need only be made at one temperature. For such purposes a rack to accommodate a panel 4 by 3 inches would fit a 12- by 8- by 5-inch laboratory muffle, and if for each particular job a temperature were used at which the glass flowed but moderately over the surface, a method would be available for quick results which should prove of particular value in smelter control work.

Acknowledgments The author wishes to acknowledge the able assistance of Donald S. Hake, Charles H. Commons, Jr., and John A. Plunkett in the development of the method described and the apparatus used.

RESEARCH LABORATORY
TITANIUM ALLOY MFG. CO.
NIAGARA FALLS, N. Y.

CERAMIC ABSTRACTS[1]

Compiled by the

AMERICAN CERAMIC SOCIETY

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Vol. 11 **June, 1932** **No. 6**

Abrasives

Auto truck axles. Anon. *Abrasive Ind.*, **13** [4], 7–11 (1932).—Many of the special grinding problems are described in detail. E.P.R.

Pipe wrench jaws repaired by grinding. H. J. Chamberland. *Abrasive Ind.*, **13** [4], 11 (1932).—The teeth of both wrench jaws are resurfaced, the necessary angle being trued on the grinding wheel face to duplicate the original angle of the teeth. E.P.R.

Grinder for lathes. U. S. Electrical Tool Co. *Brass World*, **28** [3], 58 (1932).—A new lathe grinder for use on 9-in. and larger lathes with compound rests for grinding centers, reamers, dies, rolls, small shafts, etc., is described. E.P.R.

Regrinding crankshafts, pistons, and valves for high-speed engines. Richard Wake. *Mech. World*, **91** [2357], 224–25 (1932).—W. explains methods used. E.P.R.

Vertical grinder with cup wheel. Standard Electrical Co. *Abrasive Ind.*, **13** [4], 26 (1932).—The vertical grinder described is equipped with a cup wheel 7 in. in diameter with $1^1/_4$-in. wall. The net weight is 155 lb. E.P.R.

Massive vertical grinder with two spindles. Gardner Machine Co. *Abrasive Ind.*, **13** [4], 25–26 (1932).—The work may be passed beneath two abrasive members. E.P.R.

Ground and lapped shafts for motors. Nash Motors Co. *Abrasive Ind.*, **13** [4], 12–13 (1932).—Abrasive operations followed in crankshaft manufacture reflect the results of some twenty years of experience. The operations are described in detail. E.P.R.

Polishing bicycle parts. Edward S. Heck. *Abrasive Ind.*, **13** [4], 28–30 (1932).—Particular care in polishing and buffing bicycle parts and the abrasive processes involved are described. E.P.R.

Abrasive belt machine for bench use. Production Machine Co. *Brass World*, **28** [3], 58 (1932).—A new type of abrasive surfacing and polishing belt machine for bench mounting is described. E.P.R.

Polishing wheels. Anon. *Abrasive Ind.*, **13** [4], 14–15 (1932).—Buffing is similar to polishing in that a flexible carrying medium is used, but the abrasive is not glued to the wheel. Buffing and polishing wheels are described in detail. E.P.R.

Buffing stainless steels. L. R. Eastman. *Brass World*, **28** [3], 53–54 (1932).—A discussion of buffing compositions with special reference to the methods and materials employed in finishing chromium irons and steels is given. E.P.R.

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[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

BOOKLET

Greaseless compounds for dry polishing. LEA MANUFACTURING CO. *Brass World*, **28** [3], 58 (1932).—"The Whole Story on Cutting: 3 Finishing Operations by the Dry Method," is the title of a booklet which describes in detail the qualities and uses of Lea "greaseless compounds," for all types of buffing, polishing, and cutting operations with flexible wheels. E.P.R.

PATENTS

Grinding machine. WALLACE N. APPLETON, assignor to McKay Co. U. S. 1,849,343, March 15, 1932. RICHARD HERVIG, assignor to Wilcox-Rich Corp. U. S. 1,850,349, March 22, 1932. GEORGE W. BINNS, assignor to Cincinnati Grinders, Inc. U. S. 1,850,372, March 22, 1932. CLEMENT BOOTH, assignor to Cincinnati Grinders, Inc. U. S. 1,850,373, March 22, 1932. HENRY L. CROWLEY, assignor to Henry L. Crowley & Co., Inc. U. S. 1,851,566, March 29, 1932. GUSTAVE F. KRIESEL. U. S. 1,853,907, April 12, 1932.

Abrasive wheel truing device. WILLIAM D. BARTLETT AND DANIEL KELLEHER, assignors to Ross Mfg. Co. U. S. 1,849,344, March 13, 1932.

Grinding cutters. ERLING OVEN. U. S. 1,849,849, March 15, 1932.

Grinder wheel oscillator. SOL EINSTEIN, assignor to Cincinnati Milling Machine Co. U. S. 1,849,868, March 15, 1932.

Centerless grinder. SILAS A. STRICKLAND AND THOMAS ZIMMERMAN, assignors to Cincinnati Grinders, Inc. U. S. 1,850,054, March 15, 1932.

Abrading machine. ALFRED B. FOWLER, assignor to United Shoe Machinery Corp. U. S. 1,850,098, March 22, 1932.

Dressing device for grinding elements. HOWARD D. COLMAN, assignor to Barber-Colman Co. U. S. 1,850,201, March 22, 1932.

Pulp grinding stone. WALLACE W. GREENWOOD, assignor to Norton Co. U. S. 1,850,231, March 22, 1932.

Positively actuated grinding wheel feed for saw sharpening machine, etc. JOHANN FRIEDRICH OHLER. U. S. 1,850,331, March 22, 1932.

Grinding machine, particularly for spline shafts. CLAUS JUNGE, assignor to Fritz Werner Akt.-Ges. U. S. 1,850,799, March 22, 1932.

Undercutter attachment for flexible shaft bench grinders. WILLIAM KRAUSE, assignor to Pratt & Whitney Co. U. S. 1,851,284, March 29, 1932.

Wheel dresser. JAMES J. MANDERSCHEID. U. S. 1,852,354, April 5, 1932.

Grinding wheel dresser tool. WILLIAM D. BARTLETT AND DANIEL KELLEHER, assignors to Ross Mfg. Co. U. S. 1,852,639, April 5, 1932.

Grading machine. JAMES W. JOHNSTON, assignor to Lacene Mfg. Co. U. S. 1,852,720, April 5, 1932.

Grinding cutter blades. PRESTON W. CUMMINGS, assignor to Barber-Colman Co. U. S. 1,853,667, April 12, 1932.

Flexing sheet abrasives. CHARLES H. DERBEY, assignor to Union Sandpaper Co. U. S. 1,854,021, April 12, 1932.

Manufacturing abrasives. ELMER C. SCHACHT, assignor to Behr-Manning Corp. U. S. 1,854,071, April 12, 1932.

Manufacture of abrasives, grinding wheels, blocks, etc. C. H. THOMPSON AND R. A. DEMMÉ. Brit. 367,114, Feb. 24, 1932.

Grinding or abrading machines. CINCINNATI GRINDERS, INC. Brit. 367,342, March 2, 1932, and 369,390, March 31, 1932.

Portable electrically-driven sandpapering and polishing machines. A. A. HARDING AND B. WILD. Brit. 367,769, March 9, 1932.

Devices for grinding or cutting cylinders, etc. J. W. BAILEY. Brit. 368,003, March 9, 1932.

Grinding machine for crank shafts. H. J. ERIKSEN. Brit. 368,761, March 23, 1932.

Grinding razor blades. W. OSBERGHAUS. Brit. 368,997, March 23, 1932.

Treating surfaces by grinding, polishing, etc. F. BANDEL. Brit. 369,354, March 31, 1932.

Producing grinding wheel for flour mills, pulp mills, etc. J. W. YOUNG. Brit. 369,378, March 31, 1932.

Art and Archaeology

Experiment in Egyptian blue glaze. CHARLES F. BINNS, MYRTLE KLEM, AND HAZEL MOTT. *Jour. Amer. Ceram. Soc.*, **15** [5], 271–72 (1932).

A copper blue at cone 9. EDGAR LITTLEFIELD. *Jour. Amer. Ceram. Soc.*, **15** [5], 269–70 (1932).

Production and control of copper reds in an oxidizing kiln atmosphere. ARTHUR E. BAGGS AND EDGAR LITTLEFIELD. *Jour. Amer. Ceram. Soc.*, **15** [5], 265–69 (1932).

Crystalline glazes. ALBERT GRANGER. *Ceram. Verrerie*, **833**, 609–13; **834**, 673–77 (1931); **835**, 5–9 (1932).—G. presents an excellent digest of most of the important work that has been published on the subject of crystalline glazes. The zinc-silicate, titanium, manganese, aventurine, and lead chromate glazes are discussed and the effect of different oxides on the coloration and crystallization is noted. Over 50 glaze formulas are given. T.N.McV.

Sand-blasted glass decoration. JACQUES WOLF. *Glass Ind.*, **13** [4], 59–62 (1932); see also *Ceram. Abs.*, **11** [4], 238 (1932). E.J.V.

Art glass window. ANON. *Amer. Glass Rev.*, **51** [25], 17 (1932).—One of the tallest windows in the world has been placed in the Washington Cathedral (Episcopal) in Washington. The window is 65 ft. high and the design in art glass was worked out by E. E. Sanborn, of Boston. The window depicts the transition from the camel caravan to the modern airplane and radio in the dissemination of the message of Christianity. E.P.R.

Use of colonial and military colors. ANON. *Ceram. Ind.*, **18** [4], 246 (1932).—Owing largely to the celebration of the Washington Bicentennial all lines of merchandise, including china, pottery, glassware, and dinnerware, have adopted colonial and military colors. A list of 16 colors is given, including the blue and buff of Washington's uniform and the blue and red of the flag. W.W.M.

Color in table setting. BETTY THORNLEY STUART. *Collier's*, **89** [16], 20 (1932).—This nontechnical discussion is on the use of china and glass without clash in the combination of room, flowers, and food. The difference between earthenware, china, and porcelain is briefly explained. Illustrated. See also *Ceram. Abs.*, **11** [2], 75 (1932). E.J.V.

Artistic enameling. ANON. *Ceram. Ind.*, **18** [4], 232 (1932).—Stylists say an interest in artistic enameling is being revived in America. W.W.M.

National crisis and the D. I. A. ANON. *D. I. A. Quarterly*, pp. 6–7 (Jan., 1932).—The Design and Industries Assn. of England is endeavoring to help in the present business crisis by establishing systematic contact with British manufacturers and inducing them to improve their designs, thereby reacting on public taste. (*D.I.*)

The designer in the pottery industry. GORDON FORSYTH. *Pottery Gaz.*, **57** [658], 513–17 (1932).—F., superintendent of art instruction in the potteries for 30 years, presents a statement of the work of a designer in the pottery industry. E.J.V.

Glass package. MICHAEL SAVIN. *Modern Packaging*, pp. 38–39 (Jan., 1932).—Until recently the glass package with the exception of perfume bottles showed little or no modern treatment in its design. Today containers for Child's tomato cocktail, Hellman's French dressing, Mennen's skin bracer, etc., illustrate good design and the advantage of transparency in making visible the product. (*D.I.*)

New glassware by Daum. RENÉ CHAVANCE. *Mobilier et Déc.*, pp. 561–65 (Dec., 1931).—The Daum firm has been a leading exponent of modern glassware. The fabric of the glass is crystalline but solid. The surface is often etched or frosted, decorations are geometric or floral, either stylized or moderately naturalistic, frosted and plain surfaces are occasionally juxtaposed with success, and colors are clear and subdued. (*D.I.*)

Ceramic work by Jean Besnard. PAWEL BARCHAN. *Deut. Kunst. Dek.*, pp. 128–30 (Nov., 1931).—Jean Besnard makes amusing figurines, stark and compact in their ceramic contours but possessed of a subtle humor which survives the simplification process. The varied textures he secures by use of different glazes and irregularities in the clay are illustrated. (*D.I.*)

Exhibit of contemporary French artists. G. J. GROS. *Mobilier et Déc.*, pp. 548–54 (Dec., 1931).—The exhibit brought together many of the best-known craftsmen in France. Dumand showed vases of lacquered metal, Navarre massive glassware like unpolished gems, Simmen rough pottery, Lenoble stucco-like vases, Linossier jars with geometric designs, and Daurat a bowl with raised bands for decoration. (*D.I.*)

Glass handicraft and national art in Germany. F. LERNER. *Rhein. Glasenmeister*, **11** [5 and 7], 2 (1931); *Glastech. Ber.*, **10** [2], 92 (1932).—L. discusses German glass handicraft and the influence of the national art on it; glass painting, glass blowing, polishing, and cutting are described. M.V.K.

Old American ceramics. ANON. *Sprechsaal*, **65** [7], 131 (1932).—A description is given of old pottery from Mexico, Colombia, Chile, Peru, Costa Rica, Guatemala, and Bolivia, exhibited at the Berlin Academy of Arts. M.V.K.

Oddities in glass antiques displayed in New York. ANON. *Amer. Glass Rev.*, **51** [28], 10 (1932).—A large Phoenician glass bowl, cut from a single lump of glass of yellowish tint in 1000 B.C., is among the antiques collected by the Asees Khayat of Palestine and New York and exhibited in the American Art Assn. galleries in New York. Another piece is a 3rd or 4th Century A.D. Hebrew amber glass pitcher 7 in. tall with 6 sides, each side showing pressed Hebrew symbols. A small amethyst millefleurs glass bowl is inlaid with ruby and emerald glass (1st Century, B.C.). A Greco-Roman glass bowl (2nd to 3rd Century B.C.) shows a bottle when turned upside down. It is in two sections, one of which was to be filled with poisons to be removed through the bottle end. E.P.R.

Exposition of antique art. ANON. *Sprechsaal*, **65** [12], 231 (1932).—A discussion of an exposition of antique art open in Rome is given. The objects came from the excavations made in the last several years. The most interesting objects are a series of Greek vases from the valley of Trebba (Commanchio). These vases which are masterpieces of pottery are from Athens and represent decorated heads of persons. M.V.K.

Vases from Arezzo. ANON. *Sprechsaal*, **65** [7], 131 (1932).—A description of the coral-red clayware with rich decorations in relief is given. This artistic ware developed directly from Etrurian pottery before Etruria was absorbed by the Roman civilization and attained its highest art at the time of the emperor Augustus. Attempts to reproduce such coral-red pottery with a highly sintered body were not successful. M.V.K.

Further discoveries at Olynthus. D. M. ROBINSON. *Illus. London News*, **180**,

118–19 (1932).—The results of the second season's work are described. The illustrations include mosaic floors and terra cotta figurines. See also *Ceram. Abs.*, **10** [9], 623 (1931). H.H.S.

Roman art in Dalmatia. P. MARCONI. *Illus. London News*, **180**, 49–51 (1932).—Roman glass, together with statuary, etc., has been discovered at Zara on the eastern Adriatic coast. Illustrated. H.H.S.

Unknown prehistoric race in western Canada. C. HILL-TOUT. *Illus. London News*, **180**, 90–92 (1932).—Ancient kitchen-middens of British Columbia have yielded ceremonial bowls, etc., of a mysterious race preceding the Eskimos 3000 years ago. H.H.S.

BOOKS

Decorative Art, 1931. "THE STUDIO." Year Book, 1931. Edited by C. G. HOLME. 164 pp. The Studio, Ltd., London. Reviewed in *Jour. Soc. Glass Tech.*, **15** [60], 526–27 (1931). G.R.S.

Catalogue of the Leonard Gow Collection of Chinese Porcelain. R. L. HOBSON. xxxix + 108 pp., 85 plates. Quaritch, London, 1931. Price £25. Reviewed in *Times Lit. Supp.*, **31**, 27 (1932). H.H.S.

Archaeological Investigations in the Southern Cayo District, British Honduras. J. E. THOMPSON. 146 pp., 28 plates. Field Museum, Chicago, 1931. Price $1.50. Reviewed in *Times Lit. Supp.*, **31**, 13 (1932). H.H.S.

Report on Excavations at Jemdet Nasr, Iraq. ERNEST MACKAY. Preface by S. LANGDON. 95 pp., 18 plates. Field Museum, Chicago, 1931. Price $2.00. Reviewed in *Times Lit. Supp.*, **31**, 45 (1932).—A large quantity of pottery, seals, ornaments, etc., was found 15 miles northeast of Kish. H.H.S.

PATENTS

Design for range. WILLIAM D. ANTRIM, assignor to Roberts & Mander Stove Co. U. S. 86,506, March 15, 1932. STANLEY H. HOBSON, assignor to Geo. D. Roper Corp. U. S. 86,719, April 12, 1932.

Design for gas range. ROBERT B. HURT, assignor to Hardwick Stove Co. U. S. 86,524, March 15, 1932.

Design for jar. THEODORE J. PIAZZOLI, assignor to Capstan Glass Co. U. S. 86,540, March 15, 1932. EDWIN W. FUERST, assignor to Owens-Illinois Glass Co. U. S. 86,565, March 22, 1932, and 86,712, April 12, 1932. FRAZIER SMITH, assignor to Hazel-Atlas Glass Co. U. S. 86,584, March 22, 1932. FERDINAND S. BARBIERS, assignor to Hocking Glass Co. U. S. 86,656, April 5, 1932. IVOR CORDY, assignor to Hazel-Atlas Glass Co. U. S. 86,667 and 86,668, April 5, 1932.

Design for drinking glass. JAMES E. SPENCE, assignor to Hazel-Atlas Glass Co. U. S. 86,545, March 15, 1932.

Design for integral water-closet combination. BERT O. TILDEN, assignor to B. O. T. Mfg. Co. U. S. 86,547, March 15, 1932.

Design for dish or other similar article of hollow ware, china, or glass. PEER SMED AND FREDERICK W. STARK, assignors to Waldorf-Astoria Hotel Corp. U. S. 86,554, March 15, 1932.

Design for plate, etc. YUKIO BUMA, assignor to Morimura Bros., Inc. U. S. 86,557 to 86,561, March 22, 1932. STUART JOHNSON, assignor to Hugh C. Edmiston. U. S. 86,722, April 12, 1932.

Design for bottle. GUY T. GIBSON, assignor to Guy T. Gibson, Inc. U. S. 86,566, March 22, 1932. CAROLINE G. HUMPHREYS. U. S. 86,570, March 22, 1932. PHILIP BUCHBINDER, assignor to Terri Cosmetics Corp. U. S. 86,595, March 29, 1932. FERDI-

NAND W. NITARDY, assignor to E. R. Squibb & Sons. U. S. 86,629, March 29, 1932. JEAN W. BICKS, assignor to F. A. Blichert Mfg. Co. U. S. 86,657 and 86,658, April 5, 1932. ERNEST E. BILBY, assignor to Hemingray Glass Co. U. S. 86,659, April 5, 1932. GEORGE N. MAS. U. S. 86,680, April 5, 1932. PETER DELICH, assignor of 30% to Rudolph Z. Vokovan. U. S. 86,702, April 12, 1932.

Design for tumbler. EARL W. NEWTON. U. S. 86,626, March 29, 1932.

Design for bowl, etc. EARL W. NEWTON. U. S. 86,627, March 29, 1932.

Design for goblet. EARL W. NEWTON. U. S. 86,628, March 29, 1932.

Design for plate glass. ARTHUR VOELSKOW, assignor to Vereinigte Zwieseler & Pirnaer Farbenglaswerke A.-G. U. S. 86,689, April 5, 1932.

Design for plate. ALBERT M. WALKER, assignor to Bailey-Walker China Co. U. S. 86,692, April 5, 1932.

Design for combination soap holder and grab rail. STEPHEN D. BAKER. U. S. 86,694, April 12, 1932.

Design for covered dish. STUART JOHNSON, assignor to Hugh C. Edmiston. U. S. 86,723, April 12, 1932.

Design for combination bottle and closure cap. MAE JOSEPH, assignor to Park & Tilford. U. S. 86,724, April 12, 1932.

Design for glass jar. HARRY R. MCDONALD, assignor to Hart Glass Mfg. Co. U. S. 86,730, April 12, 1932.

Design for lamp globe. RAYMOND V. OWEN, assignor to Macbeth-Evans Glass Co. U. S. 86,738, April 12, 1932.

Production of terra-sigillata coatings on ceramic ware. A. COMES. Brit. 369,135, March 23, 1932.

Providing objects of ceramic materials, particularly porcelain, with metallic coatings. C. LANOOY. Brit. 369,534, March 31, 1932.

Ornamenting ceramic products. JULIUS HERING & SOHN. Ger. 535,245, June 20, 1929. For the production of white or clear colored designs on a colored ground, a flux is painted, printed, or otherwise applied in the required design, and is then fired on at the same time as the ground color or subsequently. (*C.A.*)

Glazed ceramic masses. DEUTSCHE GOLD- UND SILBER-SCHEIDEANSTALT VORM. ROESSLER (Hermann Bollenbach, inventor). Ger. 535,540, July 2, 1927. Unsintered glazing masses containing B_2O_3 are prepared by mixing B_2O_3 with borates and glaze such as PbO, SiO_2, marble, kaolin, etc. In an example, $Ca_3(BO_3)_2$, marble, kaolin, SiO_2, and red lead are mixed. (*C.A.*)

Cements

Practical value of composition formulas. N. NICOLAESCO. *Rev. mat. constr. trav. pub.*, No. 269, pp. 45–47 (1932).—The quality of Portland cement depends on the following factors: (1) the physico-chemical state of raw materials, (2) the composition of raw materials, and (3) the "clinkering." Clinkering is determined by the kiln, the régime of the kiln, fuel, and flame, and the length and intensity of firing. These 3 factors are closely interrelated in the sense that for a certain chemical composition and a definite physico-chemical state of the raw materials, the clinkering must be accomplished in the conditions imposed by the values of the factors given above, or, for a definite physico-chemical state, certain limits of the chemical composition can not be overstepped because firing becomes impossible in the normal conditions of manufacture beyond these limits. Therefore, the formulas for the composition of cement represent particular cases and can not be used in cement plants. All of the theories and composition formulas treat

only the "indispensable constituting elements," while the "auxiliary constituting elements" have the greatest influence on the clinkering, such as sodium, potassium, and titanium oxide, which lower the temperature of clinkering considerably. M.V.K.

Examination of alite. I. WEYBE. *Zement*, **20** [5], 96–100 (1931); *Rock Prod.*, **35** [7], 58 (1932).—W. reviews the results of researches on the occurrence and definition of alite in cement clinker made by other workers. Guttmann and Gille considered alite as a mixed crystal primarily of tricalcium silicate and tricalcium aluminate. W. tried clinkering various mixtures of these two compounds and studied the product with the microscope and X-ray. He concluded that quantities of tricalcium aluminate possibly entering into combination with tricalcium silicate can, at the most, amount only to 3% and that alite, the principal mineral and carrier of the hydraulic properties of Portland cement clinker, is practically pure tricalcium silicate. It appears doubtful whether the mixed crystal theory can still be maintained, while the theory recognizing alite as a compound of β $2CaO{\cdot}SiO_2$ and of the "true" alite or mixed crystals of $2CaO{\cdot}SiO_2$ plus considerable quantities of $8CaO{\cdot}2SiO_2$ Al_2O_3 likewise corresponds no longer to the present state of research on alite. See article by Guttmann and Gille, *Ceram. Abs.*, **11** [2], 78 (1932). W.W.M.

Studies on the synthesis of calcium silicates. III. S. NAGAI AND K. AKIYAMA. *Jour. Soc. Chem. Ind.* [Japan], **35** [2], 65–67 (1932).—The results of the studies on the thermal synthesis of tricalcium silicate $3CaO{\cdot}SiO_2$ (1) from the mixture $3CaO : SiO_2$ (3 : 1) and (2) from the mixture $x(3CaO : SiO_2) + y(2CaO : Fe_2O_3)$ are given. In the first case it was found that 60 to 70% of the $2CaO{\cdot}SiO_2$ was already formed at 1200 to 1300°C. At 1600°C a small amount of $3CaO{\cdot}SiO_2$ was formed. The products heated to 1400° or above crumbled to powder on cooling because of the transformation of tricalcium silicate to dicalcium silicate and free lime, and the change of the α or β form of the dicalcium silicate to the γ form. In the second case, the results of studies on the synthesis of CaO and SiO_2 in the presence of small quantities of Fe_2O_3 or Al_2O_3, or both, show that $3CaO{\cdot}SiO_2$ is easily obtained in the presence of a small quantity of Fe_2O_3. For Parts I and II see *Ceram. Abs.*, **11** [5], 291 (1932). M.V.K.

Hydrothermal synthesis of calcium silicate at ordinary pressure. I. S. NAGAI. *Jour. Soc. Chem. Ind.* [Japan], **34** [10], 378–81*B* (1931).—Samples composed of CaO and SiO_2 in proportions of 1 : 1 and 3 : 2 were heated in an electric tube furnace in a mixed atmosphere of superheated water vapor and air at 600 to 1100°C for 1 hour. The conclusions are as follows: (1) CaO and SiO_2 are not completely combined at 1100°C in the short heating time (1 hour); (2) the calcium silicate, $3CaO{\cdot}2SiO_2$, is produced at lower temperatures (600 to 800°); (3) it is changed to $2CaO{\cdot}SiO_2$ between 800 and 900°C; and (4) above 900° only $2CaO{\cdot}SiO_2$ is produced. M.V.K.

Trass cements. A. GUTTMANN AND F. GILLE. *Tonind.-Ztg.*, **56** [4], 43–45 (1932).—Several cements were tested to which were added 30 to 50% trass. It is shown that the adhering strength of the mixtures was smaller than with the cements alone. The shrinkage of the mixtures, however, was less than that of the cements. *Ibid.*, **56** [6], 75–77; [7], 90–92 (1932).—A further report is given on experiments with trass cements. W.M.C.

Natural cement mortar after half a century. P. H. BATES. *Eng. News-Rec.*, **108**, 96 (1932).—The results of strength tests of specimens of natural cement mortar 35 to 50 years old are given. The former showed an average compressive strength of 11,300 lb./sq. in., and the latter 4680 lb./sq. in. The lower strength of the latter specimen does not indicate retrogression in strength as different materials were employed in the two cases. Of special interest is the fact that the cement was made from high magnesia rock and probably contained at least 8.5% MgO. W.L.

Specific heats of cement clinkers. H. E. SCHWIETE. *Tonind.-Ztg.*, **56** [22], 304–306

(1932).—The mean specific heats of cement clinkers were determined in the range from 18 to 1450°C by means of a calorimeter. The data show a good agreement with the former investigations by White, whereas no agreement was obtained with those by Hartner. W.M.C.

Mineralogy of cement. A. C. DAVIS. *Cement & Cement Mfg.*, **4** [12], 1351 (1932).—The results obtained by X-ray methods, microscopic examinations, and chemical methods support and confirm one another. The collective results define the major constitution of Portland cement. They indicate (1) that the most abundant constituents are tricalcium silicate and β dicalcium silicate; (2) that there are normally present in addition, tricalcium aluminate, tetracalcium alumino ferrite, and magnesia; and (3) that free lime is not normally present in amounts as great as 2.5%. W.L.

Studies on aluminous cements. II. RENATO SALMONI. *Giorn. chim. ind. applicata*, **13** [12], 583 (1931).—On the basis of further tests on the thermal phenomenon accompanying the setting of aluminous cements, S. concludes that the end of the setting does not correspond to the end of a period of hydration started at the beginning of the setting, but rather to the appearance of a new more rapid phenomenon of hydration, probably continuing in the thermal phenomenon. An interesting relation found between the accelerating or retarding properties of different substances on the setting and the p_H which their solutions have when shaken with aluminous cements is discussed. For Part I see *Ceram. Abs.*, **10** [12], 824 (1931). M.V.K.

Investigations of the setting of plaster of Paris. C. S. GIBSON AND R. N. JOHNSON. *Chem. & Ind.*, **51** [4], 25–38 (1932).—A summary is given first of the more important published researches relating to the subject. In the second part the effect of conditions of mixing on the setting properties are treated. Results are shown in the form of curves. Six classes of salts were investigated to determine the effect of soluble salts on the rate of setting. Curves are given in the discussion of the results of the tests. G.R.S.

Revision of British standard Portland cement specification. ANON. British Standard Specification No. 12, 1931; *Rock Prod.*, **35** [3], 61 (1932); *Cement & Cement Mfg.*, **4** [12], 1339 (1931).—Permissible limits of fineness remain at 10 and 1.0% residue on the British standard sieves Nos. 170 and 72, respectively. Maximum limit of lime to silica plus alumina is increased to 3.0 instead of 2.9. Neat tensile tests and 28-day 1 to 3 mortar tensile tests are deleted. The 3- and 7-day mortar tensile strengths have minimum values of 300 and 375 lb./sq. in., respectively. A normal consistency test for neat cement paste is required to determine the amount of water to be used in mortar test specimens. Time of gaging for setting time test should be not less than 3 nor more than 5 min. Duration of boiling test is reduced from 6 to 3 hr. Maximum loss on ignition is 3.0% and insoluble residue 1.0%. See following reference. W.L.

British standard specifications for Portland cement. TSOUNTAS. *Rev. mat. constr. trav. pub.*, No. 269, pp. 52–53 (1932); see preceding abstract. M.V.K.

BULLETIN AND BOOK

Tests of plain and reinforced concrete made with Haydite aggregates. F. E. RICHART AND V. P. JENSEN. Price 45¢. Univ. of Ill. Eng. Expt. Sta. *Bull.*, No. 237, 82 pp. (1931).—The investigation was divided into two groups of tests, (1) those concerned with the properties of the Haydite aggregates themselves, and (2) those concerned with the properties of concrete made with these aggregates. A.A.

Technology of Portland Cement. (La tecnologia del cemento Portland.) F. F. SALERMO. U. Hoepli, Milano, 1931. 358 pp. 48.00 lire. Reviewed in *Giorn. chim. ind. applicata*, **13** [11], 548 (1931).—The technology of Portland cement is treated exhaustively. The subjects are presented in the following order: properties,

tests, and raw materials, manufacturing processes, mixing proportions of raw materials, purpose of grinding and firing, and special cements and their manufacture. M.V.K.

PATENTS

Manufacture of Portland cement. PAUL R. WHELAN. U. S. 1,852,547, April 5, 1932. The method of manufacture of Portland cement from lime and argillaceous materials, which comprises heating the lime separately from the argillaceous material until the moment of combination, then introducing the argillaceous material into contact with the heated lime, and forming a fluid compound having more than 69% combined lime and equivalent RO oxides.

Material for Portland cement composition. HAROLD H. STEINOUR, assignor to Riverside Cement Co. U. S. 1,852,595, April 5, 1932. A Portland cement composition comprising Portland cement containing borate of lime and oxychloride of lime intimately admixed therewith.

Magnesia cement composition. LEROY C. STEWART, assignor to Dow Chemical Co. U. S. 1,853,521 and 1,853,522, April 12, 1932. (1) A cement composition consisting of the active ingredients, magnesia and magnesium sulphate, together with a relatively small amount of a compound selected from the group consisting of the phosphates, citrates, and tartrates of the alkali metals and ammonia and a filler, the composition being adapted to set upon admixing with water. (2) A plastic cement composition which consists of magnesia, magnesium sulphate, and water as active ingredients, together with a relatively small amount of a soluble phosphate intimately incorporated therewith.

Enamels

Laboratory test for the hardness of sandblast sand. EMERSON P. POSTE. *Bull. Amer. Ceram. Soc.*, **11** [5], 110–13 (1932).

Report of Enamel Division Standards Committee. C. J. KINZIE. *Bull. Amer. Ceram. Soc.*, **11** [5], 130–38 (1932).

New use for enamelware. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **11** [5], 108 (1932).

Enameled steel houses. VIELHABER. *Emaillewaren-Ind.*, **9** [11], 85–86 (1932).—The plans of the Ferro Enamel Co. to build enameled steel houses are discussed. M.V.K.

Barium carbonate for colored and signboard enamels. ANON. *Glashütte*, **62** [8], 127–28; [9], 147–50 (1932).—Compositions of two transparent enamels are discussed and analyzed. They may contain a higher or lower silica and alkali content according to their use. While the first batch contains fluorspar as an opacifier, the second contains cryolite also. When fluorspar and cryolite are both used the enamel obtained is more or less opalescent according to the time of melting, while fluorspar used alone produces a vitrified enamel. With an increased soda content, the expansion of the enamel and its fusibility are increased, but the chemical capability of resistance is lowered. The defects of transparent enamels used at present are as follows: (1) The enamel becomes turbid in a short time and the delicate colors are obscured. (2) With the introduction of alkalis instead of fluorine, the chemical resistance decreases. (3) Through the change in viscosity produced simultaneously, a diffusion of the transparent enamel with the coated enamel takes place. (4) The brilliancy disappears. These defects can be remedied by introducing barium carbonate into the batch. The melting technical properties of barium carbonate are similar to those of lead oxide. Barium carbonate lowers the viscosity of an enamel. By replacing a part of the silica by barium

carbonate, the chemical resistance can be kept constant and the melting point of the enamel lowered. The mechanical properties, *e.g.*, resistance to pressure, elasticity, resistance to strokes, and breaking are increased. It also improves the brilliancy of the enamel surface, a valuable property for a coat enamel. Two successful batches for colored signboards and white enamel containing barium carbonate are given. Selenium red, yellow, brown, and new blue are developed especially well in enamels rich in silica. A high content in alkaline earths is good for iron red. It is important that the pigment does not dissolve during firing because the color action depends on the diffused reflection, although in black enamels, a part of the pigments should dissolve, thus producing a selective absorption. It was found that barium carbonate not only promotes brilliancy in the color but also increases the intensity of the color. The composition of an enamel batch giving good results is given. A table in colors shows the change in color tone produced by additions of barium carbonate. M.V.K.

Barium carbonate as a raw material for sheet enamels. VIELHABER. *Emaillewaren-Ind.*, **9** [9], 64–65 (1932).—Barium carbonate is sometimes used as a flux instead of soda. Such a glaze contains 50 borax, 60 feldspar, 15 quartz, 8 fluorspar, 7 barium carbonate, and 4 saltpeter. This mass melts at 800°. The glaze is suitable for all colors and has a good luster. In white enamel, barium carbonate also replaces soda and increases the chemical resistance of the enamel. One part barium carbonate produces 0.777 part barium oxide in the batch while 1 part soda produces only 0.585 part sodium. Instead of 1 part soda, only $^3/_4$ part barium carbonate need be used. The expansion factor of BaO is 3.0 while that of Na_2O is 10.0, and when replacing these constituents the expansion of the enamel becomes smaller. This fact prevents an extensive use of barium carbonate. A batch containing larger additions of barium carbonate and melted in a crucible produces much foam. M.V.K.

Enameling heavy sheet metal. ANON. *Emaillewaren-Ind.* [*Émail*], **9** [9], 5–6 (1932).—The enameling of heavy sheet metal is more difficult than that of thin metal because the object may not be uniform throughout in coefficient of dilatation and elasticity. A special heavy enamel should be used. Different methods of obtaining this enamel are as follows: (1) Quartz and clay are added to an ordinary enamel. Since addition of quartz produces difficulties in adherence, thermal resistance, appearance of black spots, etc., it is much better to add calcined quartz. (2) Enamels having different coefficients of dilatation are mixed, and some quartz is added to the mill. (3) In preparing a special enamel the following points should be considered: (*a*) the feldspar should be lowered and the quartz increased; (*b*) 6 to 7% fluorspar has a favorable influence; (*c*) borax should be lowered; (*d*) cryolite and nickel oxide should never be used; (*e*) the content of cobalt oxide should be about 0.5%; (*f*) the addition of 1.5 to 2% manganese dioxide is advantageous; and (g) the melting of such an enamel should not be as thorough as that of a light enamel and the temperature must be controlled all the time. This heavy enamel should not have a pronounced brilliancy after firing; a half-mat luster is preferable. M.V.K.

Barium oxide and zinc oxide in enamels. VIELHABER. *Emaillewaren-Ind.*, **9** [11], 83–84 (1932).—V. discusses the uses of barium oxide and zinc oxide in the enamel industry and gives several enamel batches for ground and marble-white enamels. M.V.K.

Defects in cast enamels, their cause and prevention. II. WALTER KERSTAN AND OSCAR KERSTAN. *Emaillewaren-Ind.*, **9** [1], 1–3; [2], 9–10; [4], 25–28; [5], 31–34 (1932).—The shrinkage and the expansion of cast iron are similar in their action on the enamel although the change of volume of the iron has a certain influence on the shrinkage. The shrinkage of the enamel must never be larger than that of the iron and constant shrinkage ratios are the best preliminary conditions for a successful enameling. The process of shrinkage in cast iron proceeds with primary building of mixed crystals and

solidification of the eutectic and depends on the temperature and time. The shrinkage of the cast is affected by its components. Carbon increases the shrinkage and the expansion is influenced by the liberation of the primary graphite (or "eutectic graphite"). The shrinkage can be decreased by regulating cooling. The expansion decreases with increased silicon content and disappears with about 3.5% Si. The quantity of primary graphite increases with increased silicon content, but the proportion of primary to the secondary graphite is of great importance. Iron rich in graphite has a lower shrinkage than that poor in graphite. The expansion and the total shrinkage increase with increased manganese content. This property is in close relationship with the reduction of the liberation of the secondary graphite. The influence of phosphorus is more injurious when there is more combined carbon and manganese and less silicon in the cast. Expansion is little affected by sulphur. The total shrinkage increases with increased sulphur content. It can be said that all materials promoting the separation of graphite, *e.g.*, silicon, and phosphorus, promote the expansion but diminish shrinkage; while materials which make the liberation of graphite more difficult, *e.g.*, manganese and sulphur, check the expansion and promote shrinkage. During enameling the iron is repeatedly heated to temperatures lying over the pearlite point and the more the iron is heated the more iron carbide is decomposed, the more the structure loosens up, and the stronger the action of expansion becomes. This can be clearly determined during the enameling of bathtubs. The expansion of the iron increases almost proportionally with increased temperature, but at 500° a clear break appears in the curve which shows the disintegration of carbide. The change of the structure of the iron during enameling is clearly seen from photos. The ground mass is pearlitic (dark) and is permeated with graphite veins; a phosphite eutectic is precipitated between the pearlitic and graphite spots. From a repeated firing, the pearlitic ground mass is disintegrated and ferrite forms the ground mass. After a third firing to 900°, carbon crystallizes in the graphite veins. The coefficient of expansion of the enamel must correspond exactly with that of the iron. Measurements show that the expansion of the enamel is similar to that of iron up to 200°, but after this temperature both coefficients differ more and more. The expansion of the enamel at 450° suddenly ceases and then rapidly increases up to its softening point. The treatment that a cast undergoes in the foundry is explained in detail, and the most common sources of defects are as follows: (1) slag, (2) formation of sand when too dry, thin, or wet, (3) quenched places, (4) hollow places or pipes, (5) cold welding, (6) sand places, (7) polished places, (8) oxidation, (9) inaccurate molding of models, (10) a cast of different thicknesses, (11) sharp bends, and (12) different kinds of tensions. For Part I see *Ceram. Abs.*, **11** [4], 226 (1932). M.V.K.

Alloys stable on heating and their use in enamel plants. ANON. *Emaillewaren-Ind.*, **9** [7], 47–49 (1932). M.V.K.

Analyses and syntheses of majolica enamels free from lead. KARMAUS. *Emaillewaren-Ind.*, **9** [8], 56–57; [9], 63–64 (1932).—There are 3 methods used for applying majolica enamels: (1) the wet enamel method where the frit ground is covered with a white enamel on which a majolica enamel containing lead is applied; (2) the powder method in which the white powder enamel is sprinkled through sieves on the fired ground coat; and (3) where the white powder enamel is sprinkled on the red hot object, the majolica powder is applied, and the object is given a finishing firing in a muffle. The high content of lead in all majolica enamels, however, causes iridescent surfaces or mat efflorescences very easily. K. describes his researches on several new products free from lead now on the market. The researches were unsatisfactory. The composition of 2 majolica enamels with a low content of lead and which give good results is given. A part of the lead is replaced by barium carbonate and the borax content is increased. M.V.K.

Measurements of heat expansion in cast enamels to prevent crazing. WALTER KERSTAN. *Sprechsaal*, **65** [12], 223–24 (1932).—The unequal expansion of iron and of the enamel produce tensions which cause the enamel to craze. According to Seger, the iron and the enamel should have a uniform expansion on heating and a uniform contraction on cooling; a perfect adherence of the enamel can occur only when the coefficients of expansion of the enamel and of the iron are equal. Practice, however, shows that the coefficient of expansion of the enamel must be smaller than that of the iron in order to obtain a faultless adherence. Moreover, the elasticity, strength, and the previous firing of the enamel are of the greatest importance. An enamel of high strength and elasticity requires a less exact adaptation of its coefficient of expansion than an enamel with less favorable properties in this respect. There are other physical properties which must be considered as decisive factors. It was found that the expansion due to heat in no case represents an additive function but proceeds irregularly at high temperatures. K. discusses the faulty nature of cast objects and its influence on the adherence of the enamel. It is impossible to enamel casts having slag inclusions and hollow spaces. Faulty shaping, *i.e.*, concave and convex places, sharp transitions, accumulations of cast, and large differences in thickness always cause crazing or bursting of the enamel. The expansion of different cast enamels and that of iron used was determined with the Chevenard apparatus to ascertain the relation of the expansion of the enamel to that of iron. The observations were made in the interval between room temperature and that of the softening point of the enamel. The results of these expansion measurements are represented in diagrams. The differences between the calculated and the measured expansions are great. The different factors used for calculating give values which can be used only for temperatures below 100°; with higher temperatures, they entirely fail to work. M.V.K.

Kaolin in the glass and enamel industry. ANON. *Glashütte*, **62** [11], 181–82 (1932).—Kaolin is used when a higher melting point is required as in alumina glasses or fritted enamels. The coefficient of expansion of the enamel is not changed; its thermal and chemical properties and stability to heat are considerably increased. It is used to advantage as an addition to the mill instead of quartz or feldspar in heat- and acid-resisting enamels. M.V.K.

Manufacture of porcelain-enameled cast bathtubs. ANON. *Glashütte*, **62** [7], 92–93; [9], 108–10; [10], 169–70 (1932).—The main requirement in the manufacture of porcelain-enameled cast bathtubs is a solidly adhering porcelain-like, lustrous enamel on a metal. The enamel must be easily fusible, not brittle, stable to temperature changes, and resistant; the cast iron must also possess certain properties. Different types of bathtubs and the most suitable shapes are discussed. Because the cast must have definite physical properties, these can be fixed by an appropriate chemical composition. Practice shows that the best results are obtained with casts containing from 3.4 to 3.60% C, 2.4 to 2.95% graphite, 2.15 to 2.55% Si, 0.45 to 0.85% Mn, 0.06 to 0.10% S, and 0.60 to 1.10% P. The expansion of the enamel and the cast should be as close as possible. Therefore, silicon, which influences this, may be increased or decreased in content. A too high sulphur content precipitates iron sulphide on the surface. The general nature of the iron is of exceptional importance; varied thickness of the cast produces tensions and leads to defective enameling. Its structure must be dense and uniform. Graphite precipitates present on the surface produce bubbles. The melting point of the enamel must be about 850° and its softening point about 650°. The low softening point is reached by a lower silica content and higher boric acid content. Barium carbonate and zinc oxide lower the melting point of the enamel and increase its resistance. Seven compositions of enamel batches are given and discussed. The silica content in batches is between 25 to 30% and that of boric acid is between 13 and 15%. The enamel

opacified with zirconium contains a high content in alkaline earths which lowers the capability of dissolving zirconium. Enamels opacified with tin or antimony compounds may have a lower alkaline-earth content. In powder enamels, the addition of opacifiers is higher than in wet enamels. The chemical resistance of the enamel is increased with an increase of the silica content and a reduction of the alkalis and boric acid content. Instead of alkalis, alkaline-earths, *e.g.*, calcium oxide and barium oxide, may be used. Zinc oxide does not act favorably. The melting is done in the usual way. Because there are no additions to the mill, the batch is more exactly controlled. The raw mixing must be done carefully to obtain a homogeneous enamel. The melting time depends on the composition of the enamel, temperature of the kiln, and type of kiln. The thread and run tests show whether the enamel is well melted. The enamel must show only small and isolated "knobs" and the "run sample" must be lustrous after cooling. The granulated particles of enamel should be dried before grinding. The grinding of the powder must not be too fine or too coarse. Data on the grinding of the enamel, depending on the mill used, are given. The frit of a ground enamel is also given. The ground must be black and have a metallic appearance. If blue places are found, it is a sign that the ground was not sufficiently fired. The firing takes about 8 to 9 minutes at 900°. The powdering is done with a "powder hammer" with a sieve. M.V.K.

Test methods to determine the fineness of grinding and the thickness of the enamel coat. H. J. KARMAUS. *Sprechsaal*, **65** [9], 16–61 (1932).—K. discusses the importance of the exact knowledge of the fineness of grinding of an enamel and describes different methods used to determine it. Methods used for ascertaining the thickness of an enamel coat are also treated. M.V.K.

Preparation and application of old copper enamel. W. GREINER. *Glashütte*, **62** [13], 220–21 (1932).—The preparation of an old copper enamel differs considerably from that of ordinary enamels in respect to melting and grinding. This enamel is exceptionally strong, very durable, does not splinter, and, in percentage, covers a larger amount of surface than ordinary enamel. The composition of an old copper enamel is borax 27.2%, diatomaceous earth 12.4%, glass 34.0%, sodium 2.3%, iron oxide 16.8%, iron vitriol 1.2%, copper oxide 4.6%, and graphite 1.5%. The mass is well mixed and thoroughly melted in portions of 10 to 15 kg. After the mass becomes liquid, it is quenched with water. The enamel must have a vitreous appearance. It is ground for a long time (15 kg. of the mass take about 38 hr. to be ground). If the enamel is not ground fine enough, nests without luster appear after firing. The enamel can be applied by a squirting pistol or by immersing the object. In both cases the enamel should be stirred continuously. The applying is done after a ground firing, and one coating is sufficient. The object is put into a special apparatus which revolves to keep the enamel from running. The firing lasts for 3 to 4 minutes at 700 to 800°. M.V.K.

Influence of tension and compression on enamel cracks. R. WEINIG. *Ceram. Ind.*, **18** [4], 250–53 (1932); for abstract see *Ceram. Abs.*, **9** [12], 1025 (1930). W.W.M.

Pickling practice. O. L. THOMAS. *Metal Cleaning & Finishing*, **4** [3], 167–70 (1932).—A general discussion of pickling technique and equipment is given. E.J.V.

New continuous enameling furnace for cast-iron and steel products. ELECTRIC FURNACE CO. *Ceram. Ind.*, **18** [4], 256–57 (1932).—A new type of continuous furnace for firing cast iron, steel, or chinaware has been placed in operation by the Electric Furnace Co., Salem, Ohio. The installation uses no hooks or overhead conveyers, greatly simplifying the tooling and handling problem. The material is carried through the furnace on a single line continuous conveyer. Electricity, gas, or oil fuel may be used. W.W.M.

Equipment for cleaning metal. XV. R. W. MITCHELL. *Metal Cleaning & Finish-*

ing, **4** [3], 139–46 (1932).—Data on washing machines are given. Illustrated. For Part XIV see *Ceram. Abs.*, **11** [5], 316 (1932). E.J.V.

Innovations in American enameling plants. H. KALPERS. *Glashütte*, **61** [25], 456–57 (1931); *Glastech. Ber.*, **10** [2], 105 (1932).—K. describes several American enameling plants in which all the processes of production are mechanized. M.V.K.

Relative importance of frit prices and application costs. TITANIUM ALLOY MFG. CO. *Ceram. Ind.*, **18** [4], 231–32 (1932).—Frit cost is not as important a consideration as the application or operating costs. Tables are supplied which show how little an increase in frit price influences the cost of coating 100 sq. ft. of ware and how much any increase or decrease in operating expenses would affect it. W.W.M.

Review of the latest developments of enameling. H. J. KARMAUS. *Sprechsaal*, **65** [12], 223 (1932).—The use of mineral boron in enamels is emphasized, although its Fe_2O_3 content may cause discolorations. It is mainly used instead of borax or boric acid in colored enamels (ground enamel) and in wet enamels with large additions to the mill. Different patented opacifiers and rust-proof coloring agents are enumerated and their uses discussed. Different drying installations and devices are described. Enamels are sifted in rotating, centrifugal, or electric sieves, and different spring pistols are described. The greatest achievements in enameling were obtained with the use of steel stable to high temperatures. Among the kilns used in Germany, the best seem to be muffle kilns with gas generators although oil firing is extensively used. In the last few years, enamel has found new fields for use, *viz.*, in the automobile industry, for different illuminating objects (reflectors), house roofs, railroad cars, Dutch tile kilns, linings of kitchen walls, furniture, tanks for breweries, washing machines, etc. M.V.K.

Book Review

The Advanced Technique of Porcelain Enameling. Edited by J. E. HANSEN. 309 pp. Price $3.50. Published by The Enamelist Publishing Co., Cleveland, Ohio.—This book is a revision and enlargement of The Technique of Vitreous Enameling published in 1927 (see *Ceram. Abs.*, **7** [9], 599 (1928)), and is primarily a textbook or handbook dealing with application methods for wet-process porcelain enamels, and various phases of enamel shop management and control. As such, it should interest ceramic students, enamel shop workers, plant foremen, and plant executives. It is written in language understandable both to technical and nontechnical men. Chapters II to X discuss the various elements entering into the processing and application of porcelain enamel on iron, such as selection and fabrication of the metal base for enameling, preparation of metal surfaces, enamel mill room practice, mill additions, colors and color oxides, application of enamels, drying and brushing, firing, inspection, and decorative effects. Chapter XI deals with the various defects and troubles encountered in enameling, and discusses their cause and elimination. Chapters XII to XV deal with process-control methods, enamel shop management, wage incentives, and accounting and budgeting as an aid to shop management. The presentation of the subject of process control is illustrated fully with charts and gives methods for making various process control tests. Chapters XVI and XVII deal with the development of enamel furnaces, refractories, and enameling equipment. J.E.HANSEN

PATENTS

Bathtub. JOHN C. CROMWELL, assignor to Steel Sanitary Co. U. S. 1,849,346, March 15, 1932.

Cleaning and pickling metals. WALDO L. SEMON, assignor to B. F. Goodrich Co. U. S. 1,852,194, April 5, 1932.

Producing enameled article. LEON I. SHAW AND ALBERT G. JOHNSON, assignors to Western Electric Co., Inc. U. S. 1,852,759, April 5, 1932.

Glass

Faraday's researches on optical glass. C. D. SPENCER AND SHANNON JONES. *Bull. Amer. Ceram. Soc.*, **11** [4], 82–83 (1932); see also *Ceram. Abs.*, **11** [2], 88 (1932).

Faraday's researches in metals and glass. ANON. *Chem. & Ind.*, **51** [3], 42 (1932). G.R.S.

Developments in optical glass manufacture. W. M. HAMPTON AND W. N. WHEAT. *Jour. Soc. Glass Tech.*, **15** [60], 306–20 (1931); for abstract see *Ceram. Abs.*, **11** [2], 95 (1932). G.R.S.

Purification of soda-lime-silica glass by antimony (3) oxide. E. ZSCHIMMER AND L. ERNYEI. *Sprechsaal*, **65** [10], 177–79; [11], 197–99 (1932).—(1) Fourteen testing melts of a soda-lime-silica glass containing 74% SiO_2, 13% Na_2O, 1% K_2O, and 12% CaO were prepared without a purifying agent but with additions of antimony (3) oxide. (2) Curves which were drawn from measurements of the number of bubbles and diameter measurements show that with increased content of antimony (3) oxide and a constant purification time, the number of bubbles decreases but the size of the bubbles increases; with a longer time of purification and a constant content of antimony (3) oxide, the same phenomenon was determined. (3) The loss of antimony (3) oxide during melting and the ratio of the 2 stages of oxidation of Sb_2O_3 : Sb_2O_5 was determined in a cold glass containing 5% Sb_2O_3 (according to the synthesis). (4) The most important result of these researches is the fact that antimony (3) oxide is an excellent purification agent acting in principle in the same way as arsenic. M.V.K.

Working properties of white hollow glass. ANON. *Glashütte*, **62** [9], 145–47 (1932).—The working properties of glass are affected by two constituents, alkalis and lime. Glasses with high sodium content are "long," and those with a high lime content are "short." While the latter are comparatively resistant to chemical attack, the former are strongly affected. The viscosity of glasses with a high lime content is decreased so that high temperatures are required for working. A high sodium and lime content acts against a good discoloration and glasses having much lime show a dirty gray-green tinge. Lime glasses also have a strong inclination toward vitrification which increases with increased lime content. Additions of barium carbonate lower these defects in glasses with a high lime or sodium content. Glasses in which a part of the lime is replaced by barium carbonate are purer and are more easily decolorized; the fusibility of the batch is promoted and the refractory walls are less strongly attacked. Barium carbonate also lessens the danger of devitrification of lime-sodium glasses. Boric acid has the same action. Although barium carbonate lowers the viscosity of glasses, it decreases their solidification temperature at the same time and glasses may be cooled at lower temperatures. This is important for the mechanical working of glass. Borax is good to regulate the length of working making the glass "shorter"; this is important when working with machines of the Roirant or Monish types. M.V.K.

Granite and syenite as raw materials for the glass and ceramic industries. BARTEL GRANIGG. *Sprechsaal*, **65** [9], 155–58 (1932).—G. describes researches made on different granite and syenite materials in which the iron silicates were removed quantitatively. Quartz feldspar mixtures and pure feldspar free from iron were obtained from granite and syenite waste in quarries. These mixtures were ground and subjected to a repeated magnetic separation which removed the iron silicate present. After three treatments, the iron content of the sand contained from 0.35 to 0.30% Fe. Glass melts made in the laboratory from the purified sand and with an addition of alkalis produced clear, transparent melts. The melt was left liquid for a longer time till the iron (0.2 to 0.3% Fe) was completely dissolved and uniformly distributed in the melt. The apparatus and methods used are described. M.V.K.

Keeping the glass melt clean. HERMANN BARTH. *Sprechsaal*, **65** [12], 219–22 (1932).—B. discusses the action of clay pieces of different shapes floating on the surface of the glass melt and used for keeping it clean from impurities during working. The advantages of using pieces having the shape of a shoe (stiefel) are given: (1) the glassmaker is protected from sulphuric vapors and other kiln gases and from the direct heat rays, (2) the worker is able to work a more homogeneous glass mass, and (3) it is possible to keep a high melting temperature in the tank by which the quantity and quality of the glass worked is considerably heightened. M.V.K.

Electrical conductivity of crystallized and glassy silicates of the Na_2O–SiO_2 system. R. SCHWARZ AND J. HALBERSTADT. *Z. anorg. allgem. Chem.*, **199**, 33–47 (1931); *Sprechsaal*, **65** [8], 141 (1932).—The electrical conductivity of a glassy product amounts to a multiple of that of a crystal of the same composition; thus for sodium disilicate, a 10^4 fold. Small additions of glassy ingredients may produce considerable increase in conductivity. By investigating crystallized sodium metasilicate, a break in the temperature-conductivity curve was observed at about 800°, which is not due to a change in modification (no thermal or optical effects were found) and for which no plausible explanation is given as yet. The recrystallization temperature is reached at 800°. The recrystallization proceeds in such a way that after the first transgression of the polyeutectic, a comparatively strong vitrification appears together with a decrease in conductivity, and a further heating is without influence. It is possible that it is due to phenomena of release. Measurements of conductivity in different glasses (20 to 34% Na_2O and 64 to 80% SiO_2) showed the known instability in the field of the transformation point between 460 and 500°. In this field, the coefficient of temperature increases with an increase in the silica content. The transition into the stable-viscous state results gradually. The assumption of Tammann that the optimal capacity of crystallization of glasses coincides with the beginning of softening was experimentally confirmed on a glass. The coefficient of temperature of glasses is smaller than that of crystals of the same composition in all cases. M.V.K.

Discoloration of glasses by X-rays. R. SCHMIDT. *Glastech. Ber.*, **10** [3], 150–53 (1932).—Ninety glasses of systematically varied compositions were exposed to X-rays. Glasses previously colorless were more or less strongly discolored after exposure. The order of magnitude of this discoloration and the resulting color tones for every glass were determined. The influence of different compounds on the discoloration is as follows: (1) With an addition of lead, barium, calcium, and magnesium oxide, the capability of discoloration of the glass considerably increases in quantitative relation. With a high content of lead oxide, the discoloration is especially strong. Small and average additions of tin oxide act unfavorably, but higher additions act somewhat better. Boric acid takes an intermediate place with a minimum capability of discoloration with 20% B_2O_3. The boric acid content does not appreciably affect the differences in the capability of discoloration. Among the other glass-forming compounds Ce_2O_3 and Sb_2O_3 are especially favorable, while Al_2O_3 acts unfavorably. Titanium glasses produce moderate discoloration but zirconium glasses show a much stronger one. Clear relations between the capability of discoloration and atomic weight or atomic volume of the oxides concerned can be recognized in the 2-valence and 3-valence glass formers. (2) The manganese glasses investigated were colorless before exposure. It is curious that a glass containing 0.5% MnO took on a violet color after exposure proving the presence of manganic ions. A glass with 0.5% Mn_2O_3 had the same violet coloring and was not exposed. Generally, the degree of discoloration in manganese glasses is small. A small addition of iron oxide to an alkali silica glass increases the capability of discoloration considerably. This capability, however, decreases strongly with an increased content of ferrous oxide. A glass with 0.5% FeO is

not discolored by X-rays. The following results determined by F. Eckert (*Jahrb. Radioaktivitat Elektronik*, **20**, pp. 153–55 (1923)) are in agreement with those of S.: All oxides of the heavy metals, in that they color the glass in a visible way, prevent the discoloration of glasses through X-ray exposure when present in a sufficient concentration. Glasses containing only traces of iron are strongly colored into brown when subjected to the same treatment. The same case as that of iron and manganese glasses was found for arsenic glasses. While the base glass (82% SiO_2 + 18% Na_2O) is only moderately discolored, the same glasses with an addition of arsenic are discolored very strongly; a glass with an 0.5% As_2O_3 is deep gray. With increased addition, the discoloration decreases and a glass with 10% As_2O_3 becomes only light yellow after exposure. (3) Alkalis are much simpler. With increased atomic weight (also increased atomic volume), the inclination to discoloration decreases. Glasses poor in alkalis (rich in silica) are less discolored than those rich in alkalis. Glasses containing 25 to 30% Na_2O turn a pure blue color after exposure due to the presence of fine particles of metallic sodium. The conclusions of Joseph Hoffmann (see *Ceram. Abs.*, **11** [1], 16; [4], 237 (1932)) that discoloration of glasses exposed to X-rays is due to (1) the heterogeneity of the amorphous phase, (2) variety of glass components or the degree of acidity of the glass, (3) derangement of coloring ions which originally produced white, (4) derangement of the brittle glass phase due to separation of crystals, (5) derangement of the lattice due to crystallized silica $(SiO_2)n$, and (6) breaking up of SiO_2 molecules or discoloration by colloidal silicon, are discussed in detail. S. states that some of these conclusions have been found correct. See also *Ceram. Abs.*, **11** [5], 294 (1932). M.V.K.

Tensile strength of glass. E. J. Gooding. *Pottery Gaz.*, **57** [658], 508–509 (1932).—After describing the apparatus used and giving a summary of the experiments made and the factors investigated, G. points out that the three factors in the results which merit attention are (1) the relation between thickness and tensile strength, (2) the "scattering" of results in some cases, and (3) the influence of mat etching and acid polishing. The surmise that surface factors influence tenacity results is justified, although the correlation obtained between tenacity and thermal endurance results is not good. E.J.V.

Volatilization from potash-lead oxide glasses, and its bearing on the corrosion of metal pots. Eric Preston and W. E. S. Turner. *Pottery Gaz.*, **57** [658], 505–506 (1932).—The process of volatilization from the surface of a molten lead glass was studied over a temperature range of 900 to 1400°, and for a period extending to 200 hours. It was shown that volatilization takes place in a manner similar to simple evaporation, the rate at any time being proportional to the partial pressure of the volatilizing constituent or constituents. Proof was obtained by actual determination of the vapor tension of the volatilizing material by means of the dynamic inert gas method, over the range 1100 to 1350°. Tests upon the crown and jib of corroded pot samples showed that the slagged interior surface of these samples is rich in lead oxide and potash with only slight penetration into the refractory. A high-temperature firing of the pot as a whole might offer a partial remedy by reducing porosity and increasing the resistance to the slagging action of the lead oxide and potash vapors. E.J.V.

Effect of furnace gases upon a commercial lead oxide glass. J. H. Partridge. *Pottery Gaz.*, **57** [658], 505 (1932).—An investigation of the reasons why a 30% lead crystal glass held in a tank furnace at 1200°C for two weeks lost its mirror-like appearance showed that the offending precipitation might be attributed to two causes: (1) The sulphur dioxide in the furnace gases dissolved in the glass and acted as nuclei for precipitation. (2) The sulphur dioxide attacked the glass chemically in such a way that the surface layer was disturbed and some substance precipitated. The nature of the precipitation would depend upon the composition of the glass. E.J.V.

Conductivity experiments on glasses. ROBERT SCHWARZ AND JOSEF HALBERSTADT. *Z. anorg. allgem. Chem.*, **203** [3], 365–72 (1932).—Studies on the type of conductivity shown by glasses carried out heretofore to temperatures up to 400°C have shown that glasses are cation conductors. In this paper a method is described for making such studies at higher temperatures. At the temperatures employed, Faraday's law holds within the limits of experimental error and indicates that in soda glass up to 600°C only the Na ions take part in the current transfer. This is also true in Thuringer glass. K ions are immobile and therefore do not assist in current transfer. No evidence was obtained to show bipole conductivity, *i.e.*, conductivity in which the silicate ions also take part. L.T.B.

The temperature at which anisotropy produced by rubbing or drawing a glass surface disappears. H. ELSNER V. GRONOW. *Z. anorg. allgem. Chem.*, **201** [1], 34–36 (1931).—If a methylene blue mirror is produced on polished glass and is rubbed in one direction, it becomes anisotropic. On heating the mirror for more than 30 min. the anisotropy disappears 12° lower than t_e, the temperature at which the glass begins to crack. The anisotropy can also be produced by drawing the glass instead of rubbing it. This shows that the molecules in the surface of the glass are oriented in the direction of the drawing. The breaking strength of quartz glass increases with a decrease in the diameter of the specimen. On tempering at 1200 to 1250°C a decrease in strength was noted. This is due to distortion of molecular chains in the surface of the glass at this temperature, when the molecules are noticeably in motion. L.T.B.

Remarks on the work of O. Koerner and H. Salmang, "Studies on the Glassy State with the Aid of a Dilatometer." E. BERGER. *Z. anorg. allgem. Chem.*, **201** [1], 144 (1931).—In the original article (see *Ceram. Abs.*, **11** [2], 86 (1932)) the authors concluded that the transformation interval does not occur on slow heating. B. denies this and maintains that due to the lowering of this temperature the more rapid expansion can no longer be detected. L.T.B.

State of undercooled liquids and glasses. FRANZ SIMON. *Z. anorg. allgem. Chem.*, **203** [1–2], 219–27 (1931).—From Tammann's studies it is known that the properties of glass vary continuously as a glass passes to an undercooled liquid. S. has studied these properties from the thermodynamical standpoint and concludes that undercooled liquids are in thermodynamical equilibrium while glasses are not, as shown from specific heat measurements. Formerly it has been maintained that amorphous phases are characterized by complete unordered arrangement of the atoms. Such disorder is only possible when (1) the atoms do not occupy any definite position, or (2) when the atoms do not exert any forces on each other. Such forces exist, however, as is shown by the tendency of materials to crystallize, and the atoms or molecules in a glass occupy a definite position which can not readily be taken by another molecule. This may be shown by the fact that the ratio of the total volume of the glass to the actual volume of the molecules themselves is small. Hence total disorder can only exist in gases at low pressures because then the forces between molecules practically disappear and the actual volume of the molecules compared to the volume of the gas is unimportant since displacement of molecules takes place readily. The degree of disorder in a material is measured by the entropy; the less the entropy the higher the order (arrangement). With decreasing temperature the order increases and the difference in entropy between the glassy and liquid state decreases with temperature and reaches zero at 0°K. A study of glycerine glass and glycerine crystals showed that the specific heats of the two forms differed considerably over the temperature range from the melting point to a certain temperature, T_s. At T_s the specific heat of amorphous glycerine reached that of ordinary glycerine, and at T_s all the properties (volume, plasticity, dielectric constant, etc.) showed decided changes. This may be explained as follows: Above T_s the

molecules do not occupy fixed positions and changes in the material are readily brought about. The difference in entropy between glass and liquid decreases as the temperature drops to T_e; or the state of order between the two approaches one another. Below T_e the molecules can no longer change position and hence changes in the order (arrangement) cease and that state which exists at T_e will persist. Below T_e a glass tends to go to that order which corresponds to the temperature in question and therefore to a state of thermodynamic equilibrium. Considerable time is required; hence glasses are not in thermodynamic equilibrium. L.T.B.

Specific gravity of glass in dependence on the temperature. W. HANLEIN. *Glastech. Ber.*, **10** [3], 126–30 (1932).—H. reviews the world literature devoted to the specific gravity or expansion coefficients of glasses over the transformation point. He describes different methods for its determination and his own method used on a medium-hard lime magnesia glass and a hard glass. The results are shown in tables and diagrams. He concludes that a complete linear relationship appears between the temperature and specific gravity over the transformation point. The existence of an aggregation point is not probable on this linear basis. M.V.K.

Processes taking place during the chemical etching of glass. FENSKE AND KOREF. *Wiss. Abhandl. Osram-Konzern.*, **2**, pp. 270–76 (1931); *Glastech. Ber.*, **10** [3], 183–84 (1932).—It was determined chemically, optically, mechanically, and by means of X-rays that the crystal forms consist only of unevenness in the glass. By means of a color solution and arrangement of the layers of the mat surface, the remaining formations were found to be glass knobs. The largest crystalline knobs of etching were 0.07 mm. in diameter and 0.006 mm. in height. The uncombined hydrofluoric acid acting on the glass forms difficultly soluble silicofluoride nuclei which grow rapidly and settle down on the glass protecting the glass surface from the hydrofluoric acid. The glass surface is gradually covered with them. The crystals grow in depth. Sudden variations in concentration of the solution may retard the growth of the crystals while the glass surrounding the crystals is cleared off. In this way, deposits of the knobs produced during etching often form noticeable terraces. When a definite size is reached, the protecting crystals break because of their low strength and interior tensions and the hydrofluoric acid again attacks the knobs present under the protecting crystals. This explains the presence of distorted or disintegrated forms with larger etching knobs. The solubility of the compounds originated during etching determines the shape of the glass knobs. The compound which crystallizes first is precipitated. Another salt crystallizes before the etching process is completed and two crystal forms are visible. An etching containing ammonium bifluoride and calcium chloride is given as an example. Additions of barium sulphate produce a supersaturation of dissolved products of decomposition, by which the nuclei are multiplied. The crystals can grow only until they come into contact. The smaller the barium sulphate particles and the thicker the paste, the finer the etching must be. M.V.K.

Yellow etching. R. SCHATT. *Sprechsaal*, **65** [7], 117–18 (1932).—S. discusses the researches of Walter Heinrich (for abstract see *Ceram. Abs.*, **11** [3], 169; [4], 237 (1932)) on the yellow etching of glass, and describes his own investigations the results of which do not agree with those of Heinrich. The processes taking place during glass etching are explained. M.V.K.

Use of rocks in glassmaking. I. I. KITAIGORODSKY AND S. W. RODIN. *Glass*, **8** [1], 8–14 (1931).—Making glass from trachyte without the use of alkalis has resulted in a glass of fair quality, in many respects better than the common alkali glasses. The trachyte may be 85% of the batch. It causes less wear on pots and linings of tank furnaces. See also *Ceram. Abs.*, **10** [4], 259 (1931). G.R.S.

Origin of compositions in melted glass. The case of Na_2O–SiO_2 glasses. ERIC

PRESTON AND W. E. S. TURNER. *Glastech. Ber.*, **10** [3], 116–20 (1932).—The authors discuss the results of previous investigations on Na_2O–SiO_2 glasses, and describe their own researches on 7 glasses of the Na_2O–SiO_2 system. The losses due to volatilization in different glasses in dependence on the time of melting were determined and the appearance of $Na_2O \cdot SiO_2$ and $Na_2O \cdot 2SiO_2$ was discussed. The results are shown in tables and diagrams. M.V.K.

Influence of small changes in the batch on glass properties. ANON. *Glashütte*, **62** [6], 89–90 (1932).—The importance of homogenizing the batch and defining certain glass compositions not only for the technical production of glass objects but also for the economical production is discussed. In replacing compounds in a given batch great difficulties are encountered because a given glass composition has definite limiting values which are considerably changed even with small changes in the composition of the batch. The variation of the properties of different glasses whose composition was slightly modified is shown in tables. Small additions of magnesia do not affect the properties of glass. The introduction of new components in the glass, *e.g.*, Al_2O_3, B_2O_3, and BaO improve the quality of glass. Al_2O_3, B_2O_3, and BaO improve the chemical durability and the mechanical properties, *i.e.*, resistance to pressure, elasticity, strength, hardness, and resistance to strokes. Al_2O_3 increases viscosity while BaO and B_2O_3 considerably decrease it. Variations in the glass composition through adding, decreasing, or replacing compounds should be made in small quantities both when using tank kilns and in mechanized production. M.V.K.

Processes of flow in the automatic working of glass in the Owens process. I. W. EITEL. *Glastech. Ber.*, **10** [3], 121–25 (1932).—E. discusses (1) the possibility of using streak formations for detecting the rate of flow, (2) hydrodynamic conditions of flowing glass, (3) interior frictions with laminated movement, (4) interior frictions with turbulent movement, (5) rate of flow in glass melts, (6) glass streaks as indicators of flow, and (7) "continuity and tenacity" of streak films. M.V.K.

Cellulose plastic material. ANON. *Chem. News*, **144** [3751], 150–52 (1932).—The possibilities of benzyl cellulose as a new plastic are enormous, owing to its unique chemical and electrical stability, its impermeability to moisture, its noninflammable nature, and the ease with which it is worked. The preparation, purification, and properties of benzyl cellulose are outlined. It may be used as safety-glass filling. G.R.S.

Influence of ferrous oxide content on the light transmission of a soda-lime-silica glass. D. STARKIE AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **15** [60], 365–72 (1931).—The glass studied had the following composition, SiO_2 75, CaO 10, and Na_2O 15. The ferrous iron was added to the glass mixture in the form of pure ferrous oxalate in amounts to give a series of glasses having 0.005 to 1.0% iron oxide. As the total iron oxide content for the ferrous glasses is increased beyond 0.5% the change in limit is quicker than for the corresponding range in the ferric series. The transmission falls considerably as small amounts of ferrous oxide are added, while the fall is slight for a ferric series beyond a content of about 0.2%. Absorption of red rays by the ferrous glasses is more than for ferric glasses. G.R.S.

Sorption of gases by glass. F. P. BURT. *Trans. Faraday Soc.*, **28** [3], 179–84 (1932).—The pressure sorption depends on the length of time gas and glass have been in contact and is found to have different values after equal periods of sorption with different samples of glass. G.R.S.

Acid volcanic rock of Kara-Dagh, Crimea. D. V. SOKOLOV AND A. F. FIOLETOVA. *Trans. State Inst. Test. Bldg. Mat.* [Moscow], No. 34, pp. 33–45 (1930); *Brit. Chem. Abs.*, p. 1265*A* (Nov., 1931).—Liparite (K_2O Na_2O 8.75, Fe 0.44, Ti 0.10%) should be suitable for glass manufacture. The presence of 0.050% V_2O_3 in andesite is recorded. (*C.A.*)

Processes taking place during acid matting of glasses. ELSA HONIGMANN. *Glastech. Ber.*, **10** [3], 154–82 (1932); for abstract see *Ceram. Abs.*, **11** [2], 92 (1932). M.V.K.

Safety and plate glass manufacture. PAUL NICOLARDOT. *Ceram. Verrerie*, No. 835, pp. 17–23 (1932).—N. discusses wire glass, laminated glass, and tempered glass. The Universal and Schumann machines for making wire glass are described. Laminated glasses are made by both the "triplex" and "neotriplex" processes. Benedictus was the discoverer of the use of cellulose compounds for laminated glass. In 1903 he accidently dropped a flask whose interior had become coated with nitrocellulose and it did not fly to pieces. He did not work on this discovery until 10 years later. The triplex method consists in coating two of the glass surfaces with gelatine, placing between them a sheet of nitrocellulose which has been softened by a special collodion solution, heating, and applying a pressure of from 10 to 12 kg. per sq. cm. The edges of the glass are sealed with a pitch. Neotriplex is made by placing a layer of cellulose acetate between two sheets of glass. The cellulose acetate is softened by means of an organic liquid containing ether, the parts are pressed together, and the organic liquid driven out in an autoclave at a temperature of 120°C. Tempered glass is cooled in either oil or hot water. This glass will carry heavier loads than ordinary glass and is more resistant to thermal changes. When it ruptures, it breaks into small pieces which do not tend to cut. This rupturing is rather slow as a glass plate may require 15 min. to disintegrate. The principle is the same as that involved in the classical Rupert's drops. T.N.McV.

Acetyl-cellulose in safety glass. FRITZ OHL. *Glastech. Ber.*, **10** [2], 75–76 (1932).—The following results were found: (1) Acetyl-cellulose is more unstable and has a greater tendency to become yellow in light the higher its total sulphuric acid content and the lower its carbonization point. (2) In safety glasses with an acetyl-cellulose intermediate layer, the resistance to breaking depends on the strength of the acetyl-cellulose. On the other hand, safety against splintering is greater if the elasticity of the acetyl-cellulose is higher. Resistance to breaking and safety against splintering, however, change considerably if safety glass is stored for a long time. (3) The lowering of the mechanical properties and the yellowing of an acetyl-cellulose foil during storing appears sooner if the total sulphuric acid content is raised, the viscosity of the raw materials is lowered, and if the viscosity is decreased with increased temperature. An intermediate layer suitable for safety glass must have the following properties: (1) a homogeneous, uniform structure, (2) a high viscosity which decreases slightly and uniformly with higher temperatures, (3) complete absence of free or combined sulphuric acid and of any other acid residues, (4) high carbonization point, (5) highest strength, and (6) highest elasticity. M.V.K.

Safety glass with acetyl-cellulose according to patent literature. TH. PESCH. *Glastech. Ber.*, **10** [2], 76–78 (1932).—P. discusses the separate processes taking place during the manufacture of safety glass according to the newest patent literature. M.V.K.

Safety glass and its manufacture. ANON. *Génie civil*, Oct., 1930; *Ind. chimique*, **18** [209], 416 (1931).—A description of the Triplex and Securit methods is given. See following abstract. M.V.K.

Triplex glass and its manufacture. ANON. *Génie civil*, Jan., 1931; *Ind. chimique*, **18** [209], 417 (1931).—A detailed description of the methods used for the manufacturing of Triplex glass is given. M.V.K.

Use of boric acid in glass. ANON. *Ind. chimique*, **18** [210], 521 (1931); *Ind. Silicati*, **10** [1], 15 (1932).—The use of boric acid is advantageous because it effects the fusibility of glass and increases its chemical resistance. Its action varies according to whether it is added to a formed glass or to its constituents. Methodical tests were made

in Germany where it was found that with regard to fusibility, the influence of boric acid is felt, especially in the proportion of about 5% in the glass composition. In larger proportions, it seems to exert an unfavorable influence. Boric acid improves the chemical resistance of glasses, although only to a certain limit. When replacing a certain quantity of soda by boric acid, the maximum quantity should be from 5 to 10%. This is also true when replacing a certain quantity of silica. Larger quantities lower the advantages of its use. Boric acid also influences the viscosity and strength of glass.

M.V.K.

Determining the radiating power of glass. W. EITEL AND B. LANGE. *Glastech. Ber.*, **10** [2], 78–80 (1932).—The authors describe researches made to ascertain the radiating power of different bottle glasses containing alumina and pure $Na_2O{\cdot}3SiO_2$ glasses. The results are tabulated. The radiation of colorless glasses is small and can be compared with that of a silica glass. The influence of ferrous oxide and cobaltous oxide, which have a high absorption in the ultra-violet and infra-red and with it a strong emission, is very distinct. The radiating power of glass colored with chromic oxide is considerably lower, although a distinct deepening of the color with a change toward the red part of the spectrum is seen. M.V.K.

Influence of raw materials on the quality of glass. ANON. *Ceram. Verrerie*, No. 828, pp. 333 (1931); *Glastech. Ber.*, **10** [2], 89 (1932).—The importance of the chemical control of raw materials is emphasized because the products show great differences in their composition and have a varied content of impurities. Sand, soda, and lime should never be used without previous testing. Three points should be determined when using sand: (1) whether its quality corresponds to the intended use, (2) whether physical impurities are present, and (3) extent of humidity content. In soda, the humidity and the quantity of free CO_2 should be ascertained. Lime should be investigated for its content in silica, alumina, iron oxide, sulphuric acid, and magnesia. The composition of feldspar must be determined before use because products of different compositions are sold on the market under the same name. This should also be done with raw materials of secondary importance, *e.g.*, arsenic and minium. M.V.K.

Physical and chemical analysis of glass. W. POPLAWSKI AND J. FABICKI. *Kron. Farm.*, **29**, 32 (1930); *Jour. pharm. chim.*, **12**, 270 (1931).—The following analytical procedure is proposed for glass containers intended to hold medicaments and pharmaceuticals, and is limited to a determination of the extent to which the glass liberates alkalinity, Ca, and Pb under the influence of heat. Place a measured volume of distilled H_2O, freed from CO_2 and NH_3, in the glass container and heat to 180° for 20 min. as in sterilization. Determine the change in p_H by the method of Michaelis (see *Chem. Abs.*, **15**, 1427). For Ca and Pb fill the glass container, respectively, with a 10% Na_3PO_4 solution (for Ca) and 0.85% NaCl solution (for Pb) and test for Ca and Pb by the usual analytical methods. (*C.A.*)

Nature and composition of glass and chemical means for rapid testing. H. RITTER. *Glass App.*, **12**, 143 (1931).—After giving a brief review of views and data on the nature of glass, R. outlines a few simple tests for detecting various constituents. These comprise (1) etching the glass with HF and then heating in a Bunsen flame, (2) heating fragments of glass in a hard test tube through which coal gas is passed to show the presence of Pb, and (3) heating the finely-ground glass with twice as much Na_2CO_3 and a little KNO_3 to detect Mn. (*J.S.G.T.*)

Notes on faults in glass manufacture. O. HERFURTH. *Glashütte*, **61**, 299 (1931).—The paper contains no new principles. Certain decolorizing agents, *e.g.*, manganese, used in glass which suffered prolonged exposure to sunlight, have their structure altered in the glass and consequently develop a distinct color. Agents of this type should be used only in combination with others and in a proportion correctly adjusted to the

nature of the batch. A reliable decolorizing mixture consists of 75 parts of 45% sodium selenite, 60 of manganese, 50 of green nickel oxide, 25 of black nickel oxide, and 1000 of powdered marble using to every 75 kg. of sand about 15 to 20 g. of the mixture, the precise quantity being ascertained by practical test. (*J.S.G.T.*)

Absorption and scattering of light in opal glasses. G. M. Dbrosti. *Phil. Mag.*, **11**, 801 (1931); for abstract see *Ceram. Abs.*, **10** [11], 761 (1931). (*J.S.G.T.*)

Effect of polishing on the characteristics of diffusion of glasses. M. Cohn. *Lux*, pp. 171–74 (Dec., 1930); pp. 24–25 (Feb.); pp. 40–41 (March, 1931); *Ind. Silicati*, **10** [1], 14–15 (1932).—Tests to determine the effect of polishing on the characteristics of diffusion of different types of glasses for illumination were made by the Société pour le Perfectionnement de l'Éclairage (Society for Perfecting Illumination). Five test pieces were prepared from the same pane composed of opal glass on clear glass: one was left unchanged, two were polished mechanically (one on the clear and the other on the opal side) and two were polished chemically in the same manner. The index of diffusion for both sides of each piece was determined. Similar experiments were made on four test pieces from a pane of homogeneous opal glass: two, polished only on one side with sand and acid, respectively; one, polished mechanically on both sides; and one unaltered. Other test pieces were prepared from clear glass polished on one and both sides, mechanically or chemically. The best diffusion of light was obtained in the case of the homogeneous opal glasses whose characteristics approach the perfect diffusing medium and on which polishing has relatively little effect. Next come the glasses composed of opal on clear glass which are more affected by polishing; and lastly, the clear glasses whose characteristics deviate most widely from theoretical diffusion. Polishing is recommended in the case of homogeneous opal glasses, but not for opal on clear glass. In the first case polishing increases the coefficient of transmission if exception is made of the case of the test piece polished with acid and the polished side turned to the source of light. Mechanical polishing which increased the transmission of a pane of opal glass in all cases, decreased that of a sphere of the same material, which is attributed by C. to the fact that, given the existence of multiple reflection on the inside walls of the sphere, the coefficient of reflection diminishes because of the irregularity which the polished surface presents. M.V.K.

Fine old English glasses. XVII. Punch and toddy lifters. Francis Buckley. *Glass*, **8** [4], 147–48 (1931).—Punch lifters, first produced about 1800, are like tiny decanters in shape having a small round hole in the center of the base. This makes the glass into a sort of siphon or pipette. The lifter was dipped into the punch bowl, and filled itself rapidly through the hole in the base. The thumb was placed firmly on top so that the liquid inside was unable to escape. The punch in the lifter was then conveyed from the bowl to the punch glass. **XVIII. Tumblers.** *Ibid.*, **8** [5], 186–88 (1931).—"Tumbler" was the name given 150 years ago to the ordinary drinking glass. Fashion demanded a decorated glass. The fluted tumbler appeared shortly after 1775. Photographs are shown. **XIX. Lamps and chandeliers.** *Ibid.*, **8** [6], 230–32 (1931).—Chamber lamps of coarse green glass were made in the 17th Century. By 1735 they were capable of burning for 40 hr. without refilling. About 1757 cut and engraved lamps were made. "Glass schandeliers" were being sold in 1714, but in 1726 the name was changed to "lustres or chandeliers," and in 1727 to "fire lustres." This was definitely cut glass which appeared shortly before 1719. **XX. Enamel glass.** *Ibid.*, **8** [7], 278–80 (1931).—Enamel glass may be defined as an opaque glass, generally white. In Bristol, "Bristol white enamel" was made, more like porcelain in appearance than any other enamel glass. Illustrations are shown of fine pieces of Bristol white enamel glass and also clear glasses showing different styles of enamel painting. **XXI. Development of the bottle.** *Ibid.*, **8** [8], 322–24 (1931).—Glass bottles for wine and beer

were probably not made in England before 1650. About 1660 glass bottles appeared in the "Export" list. The earliest bottles were of "inverted balloon" shape, *i.e.*, with long tapering necks and round globular bodies. The change to mallet shape came before 1730. About 1775 a cylindrical shape was reached and 25 years later the bottle assumed its modern form with long cylindrical body and shapely neck. For Part XVI see *Ceram. Abs.*, **10** [9], 621 (1931). G.R.S.

Art glass cutting methods. ANON. *Nat. Glass Budget*, **47** [50], 11 (1932).—A unique idea of the English art glass trade in pattern work on church windows not universally accepted among the American artists, concerns their method of illuminating pattern cutting. A rectangular opening is cut in the cutting table on a corner about 14 in. by 18 in., an electric bulb is placed down in the opening about 6 in. below the surface with a heavy $^1/_8$-in. plate flush with the cutting table top, and the complete pattern is placed on top of the plate glass so that the electric light illuminates through the pattern and dark art glass, making free hand cutting possible, instead of cutting the pattern into small separate pieces with leaded shears. E.P.R.

Swedish glass. ELSA E. TROMM. *Glashütte*, **62** [10], 166–67 (1932).—T. describes the trend of the present ornamentation of Swedish glass and some crystal glass objects produced by Simon Gaté. See also *Ceram. Abs.*, **11** [4], 239 (1932). M.V.K.

Melting glass of good quality in pot furnaces. GUSTAV GLOWNA. *Glashütte*, **62** [8], 123–25 (1932).—Glassmelting in crucibles, in a test furnace with one or two pots, or in a furnace with a dozen pots is very different. The kind of fuel used increases this difference because every fuel gasifies in its own way and every gas has a different influence on the melting process. The best glass batch loses its value when the melting process is irregular. It is impossible to set up a definite principle for the decolorizing of glass. The use of sand of a higher or lower melting temperature, the glass residue in the pot, or a change in the cullet will affect the color of the glass. A lead glass requires a different decolorizer from baryta, soda, or potash glasses. The usual decolorizers are pyrolusite, selenium, nickelous oxide, etc., and they must be exactly quantitatively defined because the smallest variation will change the color of the glass. The operation of the glassmelting furnace is described in detail and the influence of irregularities in its operation on the quality of glass is discussed. M.V.K.

Glassmelting furnace. ANON. *Glashütte*, **62** [5], 74–75 (1932); *Glastech. Ber.*, **10** [3], 185 (1932).—A new glassmelting furnace of Zotos is described which is heated by gas, oil, or coal dust; 60% of the heat generated is used, while in a normal tank only about 15% is used. M.V.K.

Manufacture of rolled plate. XIX. ERNST LUTZ. *Glass Ind.*, **13** [4], 63–69 (1932).—Several hand-operated and automatic machines for finishing edges and the methods of operating are described. Details of producing plate glass mirrors by the use of amalgam of tin, platinum, or silver, are given and precautions necessary are outlined. The lay-out of plate glass factories is described. Illustrated. For Part XVIII see *Ceram. Abs.*, **11** [5], 301 (1932). E.J.V.

Effect of temperature on metals for glass apparatus. CLYDE E. WILLIAMS. *Ceram. Ind.*, **18** [4], 225–27 (1932).—W. discusses requirements for metals used in melting, forming, and annealing operations and the development of heat-resisting materials. In general, an attempt is being made to use cheap metals, to cool with air and water, and to make frequent replacements, rather than to use the more expensive alloys. A useful contribution to the glass industry would be a metallic thermocouple protection tube that would stand continuous immersion in glass at the feeding temperature, *e.g.*, at 2000°F. W.W.M.

Machinery and methods of manufacture of sheet glass. W. E. S. TURNER. *Glass*, **8** [1], 21–29 (1931); for abstract see *Ceram. Abs.*, **11** [1], 16 (1932). G.R.S.

Sand supply and the glass industry on the Pacific coast. C. H. Modes. *Ceram. Ind.*, **18** [4], 254 (1932).—M. gives the locations, extent, and analyses of the various deposits of glass sand on the Pacific coast. The glass industry in this region is growing and all types of ware are manufactured here. W.W.M.

Street signs of shatter-proof glass used in Calif. Dayelectric Industries. *Ceram. Ind.*, **18** [4], 227 (1932). W.W.M.

Glass *vs.* slate blackboards. Foster Dee Snell and Beatrice S. Fox. *Jour. Chem. Ed.; Ceram. Ind.*, **18** [4], 237–38 (1932).—The development of a permanent glass blackboard is given and tests made comparing the slate and the glass are described and reported. W.W.M.

Glass in building construction. Anon. *Pottery Gas.*, **57** [658], 475 (1932).—The new London Daily Express building is a reinforced concrete structure with a sheath of black, polished, opaque glass held in position by frames of a stainless metal covering the entire exterior. The mechanically polished glass surface gives an almost perfect reflection. Illustrated. E.J.V.

Development of artistic taste in German glass objects. Werner Büddemann. *Keram. Rund.*, **39** [24], 347–48 (1931); *Glastech. Ber.*, **10** [2], 92 (1932).—B. discusses the artistic development of hollow and pane glass objects in Germany. M.V.K.

Modern glass and steel furniture. Anon. *Glaces et Verres*, No. 23, pp. 18–19 (1931); *Glastech. Ber.*, **10** [2], 99 (1932).—Durability and cleanliness of glass and steel furniture and its manufacture are described. M.V.K.

Glass plates as wall lining instead of clay plates. Friedrich. *Deut. Bauhütte*, No. 19, p. 308 (1931); *Glastech. Ber.*, **10** [2], 99 (1932).—F. discusses the advantages of using colored glass plates instead of clay plates and marble. They are (1) a completely even surface, (2) smoothness, (3) luminosity, (4) hardness, and (5) chemical resistance. M.V.K.

Glass as building material in architecture exhibition. Anon. *Amer. Glass Rev.*, **51** [27], 21–22 (1932).—The exhibition includes a model of an apartment house project to be made entirely of metal and glass in fabricated units. The eye sees it as made up of alternating layers of metal and glass. E.P.R.

Mirrors feature modern bathrooms. Anon. *Amer. Glass Rev.*, **51** [28], 19–20 (1932).—An exhibit of new bathroom designs in New York includes one walled completely with mirrors. Mirrors are prominent in other designs and styles. Other new forms of glass are used for the instruction of architects. E.P.R.

What the science of glass owes to George Gehlhoff. Eberhard Zschimmer. *Glastech. Ber.*, **10** [3], 113–14 (1932).—Z. discusses the significance of and enumerates the researches of George Gehlhoff and his collaborators in the field of glass technology. M.V.K.

Visits to German glassworks. A. M. Kale. *Jour. Indian Ceram. Soc.*, **3**, 63–67 (1931). A.A.

Needs of the Indian glass industry: a research council. T. W. Talwalkar. *Jour. Indian Ceram. Soc.*, **3**, 101–109 (1931).—The troubles of the glass industry are diagnosed as due to (1) lack of finances to do pioneering work, (2) difficulties in the modification of the methods used abroad to conform to the local conditions, (3) lack of education of the buyers to the Indian glassware, (4) heavy cost in training the skilled and unskilled labor, (5) lack of manufacturer's machinery, and (6) lack of adequate facilities for export trade. Some means to remedy these conditions are suggested. A.A.

Case for protection for the Indian glass industry. R. D. Chandorkar. *Jour. Indian Ceram. Soc.*, **3**, 69–76 (1931). A.A.

BOOKS

Power losses in Pyrex insulators. N. V. Naravan Swami. The Indian Science

Congress, Bengalore; reviewed from a preprint in *Jour. Indian Ceram. Soc.*, **3**, 119 (1931).—Power losses occurring in insulators made of Pyrex glass designed for different working voltages were investigated and compared with those of similar porcelain insulators. The Pyrex insulators were supplied by the Corning Glass Works for use on 8-, 23-, and 40-kv. lines, respectively, and were stressed to different voltages up to the working pressure. The measurements were taken under ordinary laboratory conditions of temperature and pressure on Schering Bridge. The observations show that with increasing stress, the power factor gradually increases from about 0.1 to 0.3 and the capacity also increases, indicating an increase in the dielectric constant of Pyrex glass. The losses at the working voltages are of the order of 2 to 3 watts. In the case of porcelain insulators of 5-and 40-kv. lines, the increase of power factor with the increasing stress is only from 0.25 to 0.3 and the capacity also shows only a small increase indicating small variation in the dielectric constant of porcelain. The dielectric losses are of the same order as in the Pyrex or the other type of insulator but the smaller size of Pyrex insulators appears to be a point in their favor. A.A.

White Glasses, Hollow Glassware, and Laboratory Glassware. (Weisz, Hohl, und Gerateglas.) FRIEDRICH SPÄTE. Vol. 7. *Z. physik. Chem.*, **157***A* [3], 320 (1931); *Z. Ver. deut. Ing.*, **75** [50], 1520 (1931); *Jour. Soc. Glass Tech.*, **15** [60], 525–26 (1931); for abstract see *Ceram. Abs.*, **10** [11], 769 (1931). L.T.B.

Mechanization of the Glass Industry. L. GESBURG AND S. PERKAL. Reviewed in *Jour. Soc. Glass Tech.*, **15** [60], 524–25 (1931); see also *Ceram. Abs.*, **11** [4], 240 (1932). G.R.S.

Book Review

The Bohemian Glass Industry in the Past and Present. (Die Böhmische Glasindustrie in Vergangenheit und Gegenwart.) AUGUSTE MITSCHERLICH. 255 pp. + 5 charts. Published by the Buchdruckerei Alois Holub, Aussig, 1930. Price 10.0 Rm. unbound. Within the past four or five years several important economic studies of the German glass industry, both of its sectional interests and of the industry as a whole, have been published. If we are to believe that these various works have all had their intelligent circle of readers, the German glass industry makes a wider study of its industrial and commercial conditions than does that in this country.

In the work now under review, M. presents a detailed survey of the development and present condition of the glassmaking industry in Czechoslovakia. The work consists of an introductory section, historical in character and descriptive of the types of glass manufacture which the Bohemian industry has developed. Six main sections follow which deal with the following subjects: the problem of location and its influence on the industrial development of the Bohemian glass industry, the technical aspect of production, the forms of operation of the Bohemian glass industry and their commercial characteristics, the forms of enterprise of the Bohemian glass industry under the influence of technological development, the employees and the social organization as dependent on the commercial development of the Bohemian glass industry, and export trade and commercial policy and their relationships to the commercial development of the Bohemian glass industry.

Each of these six sections is subdivided into two, three, or four subsections. The subject headings to the six chief sections scarcely give a clue to all of the interesting matters which form the subject of discussion. One further reference to them must, however, suffice; thus Section IV, which deals with the forms of glass enterprise in Czechoslovakia, is divided into four subsections. Herein are discussed the historical foundations for these forms of enterprises, including the origin and significance of the glass wholesale merchant who plays a big part in Czechoslovakian glass organization; the regulation of

the hollow glassware industry, which comprises all kinds of domestic glassware; the glass-bottle and sheet-glass industry; the making of artistic glass, particularly of beads and numerous products of home industry; the various commercial combinations and cartels and other forms of rationalization, and the influence of the War on the subsequent development of the Czechoslovakian glass industry. (*J.S.G.T.*)

PATENTS

Percolator construction. ALBERT F. FISCHER, assignor to Robeson-Rochester Corp. U. S. 1,849,400, March 15, 1932.

Making laminated glass. WILLIAM HENRY MOSS, assignor to Celanese Corp. of America. U. S. 1,849,504, March 15, 1932.

Glass container. CHARLES HAMMER, assignor to Anchor Cap & Closure Corp. U. S. 1,849,522 and 1,849,523, March 15, 1932.

Bottle-making machine. SYDNEY L. SEARS, assignor to Hartford-Empire Co. U. S. 1,849,555, March 15, 1932.

Producing sheet glass. FRANK FRASER, assignor to Libbey-Owens-Ford Glass Co. U. S. 1,849,796, March 15, 1932.

Shaping articles of glass. VIRGIL O. CORNWELL, DAVID L. MIDDENDORF, AND ALBERT MOELLER, assignors to Federal Glass Co. U. S. 1,849,823, March 15, 1932.

Continuous glass grinding and polishing machine. JAMES HARRIS GRIFFIN, assignor to Pilkington Brothers, Ltd. U. S. 1,849,980, March 15, 1932.

Making twin bore silica tubes. OTTO C. TRAUTMANN. U. S. 1,850,295, March 22, 1932.

Sheet glass edging machine. HENRY O. KRANICH, assignor to Libbey-Owens-Ford Glass Co. U. S. 1,850,465, March 22, 1932.

Blowing glass bottles, etc. CLARENCE R. NIXON, assignor to Baltimore Bottle Machine Co. U. S. 1,850,470, March 22, 1932.

Treating a glass article. WLODZIMIERZ MARYAN DANIEWSKI, assignor to Corning Glass Works. U. S. 1,850,537, March 22, 1932. The hereinbefore described process of preventing the bumping of a liquid when heated, which consists in heating the liquid in a glass vessel having a film of silica gel adherent thereto.

Grinding and polishing glass plates. LAMBERT VON REIS, assignor to Soc. Anon. des Ateliers Heuze, Malevez et Simon Réunis, and Pilkington Brothers, Ltd. U. S. 1,850,946, March 22, 1932.

Glass transfer mechanism. WILLIAM A. MORTON AND PAUL L. GEER, assignors to Amco, Inc. U. S. 1,850,968, March 22, 1932.

Glass rolling apparatus particularly applicable to the production of continuous glass strip. FREDERIC BARNES WALDRON, assignor to Pilkington Brothers, Ltd. U. S. 1,851,609, March 29, 1932.

Making rolled glass strips. ERNEST BRISTOW LE MARE, assignor to Pilkington Brothers, Ltd. U. S. 1,851,634, March 29, 1932.

Rolling thick plates of glass. YVON BRANCART. U. S. 1,851,803, March 29, 1932.

Rolling glass. YVON BRANCART. U. S. 1,851,804, March 29, 1932.

Molding molten glass, etc. FRANK H. LOBB, assignor to Hartford-Empire Co. U. S. 1,852,171, April 5, 1932.

Feeding molten glass. KARL E. PEILER, assignor to Hartford-Empire Co. U. S. 1,852,218, April 5, 1932. GEORGE E. HOWARD, assignor to Hartford-Empire Co. U. S. 1,853,002, April 5, 1932. LLOYD G. BATES AND FRANK E. HASKELL, assignors to Hartford-Empire Co. U. S. 1,853,842, April 12, 1932 and 1,853,843, April 12, 1932.

Glass gathering. FRANK O'NEILL. U. S. 1,852,329, April 5, 1932.

Leer feeder. ALBERT N. CRAMER, assignor to Owens-Illinois Glass Co. U. S. 1,852,556, April 5, 1932.

Glassware forming machine. VICTOR E. HOFMANN, assignor to Owens-Illinois Glass Co. U. S. 1,852,570, April 5, 1932.

Forming molten glass. GEORGE E. HOWARD, assignor to Hartford-Empire Co. U. S. 1,852,719, April 5, 1932.

Silica window pane. JAMES H. SULLIVAN, assignor to General Electric Co. U. S. 1,852,864, April 5, 1932.

Producing shaped mold charges of molten glass. GEORGE E. HOWARD, assignor to Hartford-Empire Co. U. S. 1,853,003, April 5, 1932.

Manufacture of glass articles. SYDNEY HUNT, assignor to John Walker & Sons, Ltd. U. S. 1,853,276, April 12, 1932.

Glass cutting apparatus. ROBERT P. CALLARD AND JOHN H. MOLLER, assignors to Libbey-Owens-Ford Glass Co. U. S. 1,853,298, and 1,853,505, April 12, 1932.

Sheet glass scoring device. CHARLES E. BLIVEN, assignor to Libbey-Owens-Ford Glass Co. U. S. 1,853,498, April 12, 1932.

Cam mechanism for glass-blowing machines. RUSSELL G. ALLEN, assignor to Owens-Illinois Glass Co. U. S. 1,853,714, April 12, 1932.

Glassware blowing mechanism. ROSWELL F. HATCH AND ARTHUR B. BUTTERFIELD, assignors to Hartford-Empire Co. U. S. 1,853,861, April 12, 1932.

Glass annealing leer. HENRY D. PAXTON, assignor to Highland-Western Glass Co. U. S. 1,853,878, April 12, 1932.

Insulated leer roller. ELISHA W. PAXTON AND ARTHUR W. SCHMID, assignors to Highland-Western Glass Co. U. S. 1,853,879, April 12, 1932.

Machine for forming glass articles. JOHN E. MCLAUGHLIN, assignor to Owens-Illinois Glass Co. U. S. 1,853,986, April 12, 1932.

Sealing bottles, jars, etc. A. K. CROAD, assignor to F. Gutmann & Co. Brit. 367,366, March 2, 1932.

Manufacture of laminated glass. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 367,523, March 2, 1932. DUPLATE CORP. Brit. 369,028, March 23, 1932.

Manufacture of splinterless glass. I. G. FARBENINDUSTRIE AKT.-GES. Brit. 367,633, and 367,658, March 2, 1932, and Brit. 368,657, March 16, 1932.

Arrangement for drawing hollow bodies of glass in the form of a tube or sleeve. PYREX. Brit. 367,656, March 2, 1932.

Leers. J. E. POLLAK, assignor to Hazel-Atlas Glass Co. Brit. 367,671, March 2, 1932.

Feeding molten glass. HARTFORD-EMPIRE CO. Brit. 368,089, March 9, 1932.

Manufacture of glassware. ROCKWARE GLASS SYNDICATE, LTD., AND T. WARDLEY. Brit. 368,335, March 16, 1932.

Parting and/or bottoming glass and silica tubing and/or tubes. JOHNSEN & JORGENSEN FLINT GLASS, LTD., AND E. ASHFORD. Brit. 368,419, March 16, 1932.

Tables for supporting plate glass, etc., for grinding and polishing. C. HEUZE. Brit. 369,467, March 31, 1932.

Dulling hollow glass articles internally. ELEKTRISCHE GLÜHLAMPENFABRIK "WATT" A.-G. Austrian 124,688, May 15, 1931. Use is made of a viscous aqueous etching liquid containing NH_4HF_2, $BaSO_4$, and finely divided CaF_2 produced in the liquid from $CaCl_2$ and HF. A suitable liquid is prepared from NH_4HF_2 800, $CaCl_2$ 800, H_2O 1000, HF 100, and $BaSO_4$ 100 parts. The viscosity of the liquid is such that a layer of uniform thickness can be produced by spraying it upwardly into the article to be treated. (*C.A.*)

Apparatus for drawing glass into sheets. RENÉ ARCQ. Fr. 707,973, Dec. 19, 1930. (*C.A.*)

Making a continuous band of glass. PILKINGTON BROS., LTD. Fr. 708,056, Dec. 19, 1930. (*C.A.*)

Making continuous glass plates. PILKINGTON BROS., LTD. Fr. 708,161, Dec. 20, 1930. (*C.A.*)

Furnaces for annealing glass. PILKINGTON BROS., LTD. Fr. 708,228, Dec. 22, 1930. (*C.A.*)

Glassmaking. N.-V. MAATSCHAPPIJ TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Fr. 710,121, Jan. 29, 1931. Means for transporting sheets of glass to the cooling chambers is described. (*C.A.*)

Electric induction furnace for glass manufacture. HENRI GEORGE. Brit. 299,393, Oct. 25, 1927. A metal bath is used with which the glass is in contact. Various structural features are specified. See following abstract. (*C.A.*)

Electric furnace for glass manufacture. HENRI GEORGE. Ger. 535,011, Oct. 24, 1928. See also *Ceram. Abs.*, **8** [12], 881 (1929). (*C.A.*)

Glass bottles or other hollow ware. F. ECKERT. Brit. 310,421, April 25, 1928. Air is blown into the interior of the article during its formation in molds, in order to cool the glass internally in addition to the external cooling effected by contact with the molds and exposure to the air. Brit. 310,422 also describes apparatus and mechanical features for making glass articles blown in molds. See following abstract. (*C.A.*)

Apparatus for making hollow glassware. FRITZ ECKERT. Ger. 535,013, April 24, 1929. See also *Ceram. Abs.*, **8** [8], 578 (1929). (*C.A.*)

Production of glass threads. BORNKESSEL, BRENNER UND GLASMASCHINEN G.M.B.H. Ger. 526,899, June 11, 1927. In a process for producing glass threads by heating the ends of a plurality of vertically supported glass rods by burner flames and drawing off the molten glass onto a drum, the shaft carrying the rods was provided with grooves corresponding in number with that of the rods dealt with, the rods being held in the grooves by weights suspended above them on elastic threads or wires. (*J.S.G.T.*)

Eye-protecting spectacle glass. DEUTSCHE SPIEGELGLAS A.-G. Ger. 527,642, Jan. 22, 1929. Glasses which, besides absorbing the ultra-violet, also absorb the invisible heat rays without being colored, contain more than 1% antimony oxide in addition to oxides of rare-earth metals. (*J.S.G.T.*)

Apparatus for treating molten glass in a container or furnace forehearth. DEUTSCHER VERBAND DER FLASCHENFABRIKEN G.M.B.H. Ger. 534,373, May 29, 1929. Parts of the apparatus are protected against the heat of the glass. (*C.A.*)

Glass molding machine. WM. J. MILLER, INC. Ger. 534,414, July 19, 1930. (*C.A.*)

Apparatus for making endless glass tubes. HARTFORD-EMPIRE CO. Ger. 534,415, May 22, 1929. (*C.A.*)

Glass-blowing machine. BULLMANN MACHINE CO., LTD. Ger. 534,576, Aug. 29, 1928. (*C.A.*)

Cooling furnace for glass plates. N.-V. MAATSCHAPPIJ TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 534,578, Dec. 22, 1929. (*C.A.*)

Device for delivering molten glass from the forehearth of a glassmelting furnace. DEUTSCHER VERBAND DER FLASCHENFABRIKEN G.M.B.H. Ger. 534,703, July 16, 1924. (*C.A.*)

Rolling plate glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY ET CIREY. Ger. 535,014, July 23, 1930. (*C.A.*)

Apparatus for glass tubes or rods. PIERRE A. FAVRE. Ger. 535,015, March 5, 1930. (*C.A.*)

Annealing furnace with transport rollers for glassware, etc. N.-V. MAATSCHAPPIJ TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 535,016, Sept. 11, 1929. (*C.A.*)

Apparatus for rolling sheet glass. YVON BRANCART. Ger. 535,183, Oct. 10, 1929. (*C.A.*)

Glass. PAUL BORNKESSEL AND MARGARETE CMOK NÉE JOHN. Ger. 535,781, Dec. 21, 1924. A device for separating plastic glass pieces from a supply of molten glass for the manufacture of glass articles is described. (*C.A.*)

Rolling plate glass. ARTHUR BRANCART. Ger. 535,992, Oct. 10, 1929. (*C.A.*)

Means for conveying intermittently rolled glass plates to a number of leers. N.-V. MAATSCHAPPIJ TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 536,374, Aug. 9, 1929. (*C.A.*)

Apparatus for rewarming lenses and other glass pieces. EMIL BUSCH A.-G. OPTISCHE INDUSTRIE. Ger. 536,478, April 23, 1930. (*C.A.*)

Apparatus for forming glass tubes or other material plastic when heated. SOC. ANON. "LE PYREX." Ger. 536,757, Feb. 18, 1930. (*C.A.*)

Canal cooling furnace for glassware. OTTO MAETZ. Ger. 536,758, Aug. 17, 1929. (*C.A.*)

Device for drawing off fused glass from the furnace. EUROPÄISCHER VERBAND DER FLASCHENFABRIKEN G.M.B.H. Ger. 536,796, Dec. 25, 1925. (*C.A.*)

Pressure vessel for nonsplintering glass. DU PONT VISCOLOID CO. Ger. 537,489, Oct. 8, 1929; see also *Ceram. Abs.*, **10** [3], 187 (1931). (*C.A.*)

Structural Clay Products

Results of tests on ten demonstrations of reinforced brick structures with summary covering tests on thirteen structures. EDWARD E. KRAUSS AND JUDSON VOGDES. *Jour. Amer. Ceram. Soc.*, **15** [5], 273–300 (1932).

Method of testing reinforced brick masonry demonstration structures. EDWARD E. KRAUSS AND JUDSON VOGDES. *Jour. Amer. Ceram. Soc.*, **15** [5], 300–305 (1932).

Preliminary outline of program of research in reinforced masonry. EDWARD E. KRAUSS AND JUDSON VOGDES. *Jour. Amer. Ceram. Soc.*, **15** [5], 305–13 (1932).

Tentative specifications for reinforced brick masonry. EDWARD E. KRAUSS AND JUDSON VOGDES. *Jour. Amer. Ceram. Soc.*, **15** [5], 313–20 (1932).

Determining loading characteristics on reinforced brick masonry. T. G. MACCARTHY. *Brick Clay Rec.*, **80** [3], 148–52 (1932).—A report of tests made on slabs and beams to ascertain the characteristics of reinforced brick masonry when loaded to failure is presented in tabular form with explanations of methods of making the tests. E.J.V.

Developments in the use of reinforced brickwork. ANON. *Engineering*, **131**, 44–45 (1931).—Illustrated. A.A.

Reinforced brickwork. ANON. *Engineering*, **133** [3442], 20 (1932).—The system makes necessary special forms of brick. The method consists of threading the brick over reinforcing bars arranged at right angles to courses. The holes and grooves are filled with cement mortar as building proceeds. The process requires no shuttering which makes the work expeditious and the brickwork can take its load almost immediately. A.A.

Reinforced brick masonry display. ANON. *Clay-Worker*, **97** [3], 136 (1932).—Through the coöperation of H. C. Carroll & Sons and the Committee on Reinforced Brick Masonry of the National Brick Manufacturers' Research Foundation, an exhibit

of reinforced brick masonry has been set up in Philadelphia. The display includes more than fifty large photographs and a number of scale models. Illustrated. E.J.V.

Practical application of reinforced brick masonry in brick plant. ANON. *Clay-Worker*, **97** [3], 136–37 (1932).—The Alwine Brothers Brick Co., New Oxford, Pa., has completed buildings using reinforced brick masonry exclusively for lintel construction. The type of construction used and details of size of lintels, etc., are discussed. Illustrated. See also *Ceram. Abs.*, **10** [4] 270; [12] 841 (1931). E.J.V.

Advantages of fired clay products. HENRI GILARDONI. *Brit. Clayworker*, **40** [479], 431–32 (1932).—Antique brick and tile are well preserved because of their resistance to atmospheric influences. The advantages of fired clay products over other materials are reviewed and illustrated. Their superiority in conductivity, permeability to air and gases, greater crushing strength and safety of construction, decorative possibilities, advantages of economy in construction, and the interlocking tile are stressed. R.A.H.

Production of gray brick. L. P. COLLIN. Can. Dept. Mines, *Mines Branch Rept.*, **722**, 22–23 (1931).—From 0.5 to 4% MnO_2 and 2 to 12% limestone dust were added to Ontario and Quebec clays. To obtain a gray brick 4% MnO_2 and 8% limestone dust were necessary. (*C.A.*)

Preparing clay for brickmaking. E. HUETTEMANN. *Tonind.-Ztg.*, **56** [16], 227–28; [18], 251–53 (1932).—The properties of three clays required different machines to secure satisfactory products. Arrangement of the installations and their operation are discussed. Illustrated. W.M.C.

Brick slab and metal stripping used in veneer development. NOONAN LUMBER CO. *Bldg. Supply News*, **42** [4], 200 (1932); *Brick Clay Rec.*, **80** [3], 146 (1932).—A brick veneer method which involves the use of a clay brick slab about $1^1/_8$ in. thick and metal stripping in surfacing a building has been developed. Illustrated. E.J.V.

Influence of autoclave conditions on the strength of sand-lime brick. G. E. BESSEY AND F. M. LEA. *Chem. & Ind.*, **51** [11], 91–94 (1932).—Results of the tests are as follows: (1) Changes in the proportion and quality of lime and amount of water used or variations in the sand will not appreciably affect the limiting steam pressure of about 160 lb./sq. in. above which for a constant period of autoclaving, little increase in strength is obtained. (2) The strength-time of the autoclaving curve may, at constant steam pressure, undergo some change when the mix is varied in that the time will alter before maximum strength is reached. (3) The values of the wet-dry strength ratio may similarly suffer some change. (4) The curve relating free lime content to compressive strength will be displaced toward higher or lower strengths as the total lime content and nature of the mix are varied. G.R.S.

Closed end clay units. A. ZIERER. *Brick Clay Rec.*, **80** [3], 153 (1932).—Z. suggests a clay block with 5 sides closed and the 6th side open produced in a large building unit which is easy to handle and as light as an ordinary sized brick. Illustrated. E.J.V.

Manufacture of tile. ANON. *Ziegel and Zement*, No. 28, p. 295 (1931); *Rev. mat. constr. trav. pub.*, No. 269, pp. 21–22*B* (1932).—The preparation and process of different clays for drain tile manufacture are discussed. Particular attention is given to lime in clays. M.V.K.

Porosity of brick and their resistance to freezing. H. HIRSCH. *Tonind.-Ztg.*, **56** [21], 290–91 (1932).—The freezing resistance of brick was tested by means of a device specially developed in the Tonindustrie-Laboratorium in Berlin. Freezing resistance is not related in a simple way to the porosity, whereas the form of the pores, strains in the brick, and structural defects will affect it greatly. W.M.C.

Neutralizing the effect of lime in calcareous clays. ANON. *Corriere ceram.*, **13** [2], 75 (1932).—Calcareous clays are rendered inoffensive by means of (1) a sufficiently

fine grinding, (2) mixing with finely powdered coke, and (3) firing with a deoxidizing atmosphere in the last phase. The coke, when thoroughly mixed in, reduces the sulphates to sulphides which are harmless, and the high temperature reached permits the lime to combine with the clay and become insoluble. The method is patented. M.V.K.

Management of a brick plant during economic depressions. STRECK. *Tonind.-Ztg.*, **56** [21], 288–90; [23], 321–23 (1932).—The adjustment of a brick plant to the smaller demand during times of economic depressions is described. Several means are proposed, including reduction of salaries, introduction of mechanical means to handle the clay, and improved transportation facilities. Special care is to be taken to produce a good quality of brick and to consider the production of new articles. W.M.C.

Calculation in brick plants. ANON. *Tonind.-Ztg.*, **56** [17], 239–41 (1932). W.M.C.

Designing with brick. G. MEREDITH MUSICK. *Brick Clay Rec.*, **80** [3], 138–41 (1932).—The decorative possibilities of brickwork, based on personal experience, are shown. E.J.V.

Shipping protection for face brick. ANON. *Brick Clay Rec.*, **80** [3], 17–72 (1932); *Clay-Worker*, **97** [3], 149 (1932).—The Hinde & Dauch brick shield is described. Illustrated. E.J.V.

Definite quality grading rules to govern face-brick sales. ANON. *Brick Clay Rec.*, **80** [3], 154–56 (1932); *Clay-Worker*, **97** [3], 152–55 (1932).—The standard grading rules of the American Face Brick Assn. are presented. E.J.V.

Brick plant 10,000 feet above the sea. G. R. FAIRBANKS. *Brick Clay Rec.*, **80** [3], 168 (1932); *Clay-Worker*, **97** [3], 145 (1932).—A plant established by Nicolas Delgado in Quito, Ecuador, produces 25,000 brick daily using a Hoffman kiln. Illustrated. E.J.V.

Data. V. T. W. GARVE. *Clay-Worker*, **97** [3], 150–51 (1932).—G. discusses air as to (1) its constituents, (2) analysis, (3) pressure, (4) weight, (5) humidity, (6) wind pressure, and (7) speed. The elements of broad measure, circular inch, and circular mil are given. For Part IV see *Ceram. Abs.*, **11** [4], 281 (1932). E.J.V.

Fundamentals and economies in the clay industries. XIV. ELLIS LOVEJOY. *Clay-Worker*, **97** [3], 138–39 (1932).—The value of detailed plans in building or remodeling is stressed, and the use of a contour map of the property is discussed. In the preparation of new plans the first step is a flow sheet and the routing of the material the shortest possible distance. Lighting, ventilating, heating, dust elimination, excess working space, future extensions, drainage, location of the clay and entry to the factory, and shipping and supply tracks are discussed fully. For Part XIII see *Ceram. Abs.*, **11** [5], 305 (1932). E.J.V.

Can machines replace manual labor in India? ANON. *Jour. Indian Ceram. Soc.*, **3** [3], 94–100 (1931).—In the case of brick and tile plants the relative costs of machine-made and hand-made products are discussed and compared. A.A.

Apparatus for cutting brick, etc. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 267, pp. 230–32*B* (1931); No. 268, pp. 11–13*B*; No. 269, pp. 32–36*B* (1932).—P. details methods in France for preparing raw materials and apparatus used for working them. See also *Ceram. Abs.*, **11** [3], 192 (1932). M.V.K.

BULLETIN

Utilization of pebbly clays for heavy clay products manufacture. FRED. T. HEATH. O.S.U. Eng. Expt. Sta. *Bull.*, No. 59, pp. 1–48 (1930).—A study was made of the use of clays containing calcareous pebbles in the manufacture of fired clay products. Hard firing, firing under reducing conditions, and fine grinding tend to minimize the bad effects

of CaO pebbles. Additions of a fluxing salt, such as NaCl or $CaCl_2$, promote conversion of the CaO into Ca silicates and renders the smaller CaO particles less harmful. Na_2SO_4, Na_2CO_3, and $NaHCO_3$ are not effective. Air slaking is much more harmful than water slaking on fired ware containing CaO pebbles. The amount of water required to bring a clay into a state of fluidity where it can be economically forced through a grid sufficiently fine to remove the smaller pebbles is considerable, and the power requirements mount rapidly as the size of the slots and the water content of the clay are decreased. After a clay has been made sufficiently plastic to be easily forced through a slot device containing openings small enough for proper cleaning, only a small additional amount of water is required to bring it to such a fluid state that it can be screened. (*C.A.*)

PATENTS

Making building brick. HUMBERT M. FENATI. U. S. 1,849,366, March 15, 1932.

Furnace mechanism and process for bloating clay. EDWIN M. WYATT AND HOWARD F. WEISS, assignors to American Face Brick Research Corp. U. S. 1,850,221, March 22, 1932.

Brick. GEORGE B. KISSINGER. U. S. 1,850,884, March 22, 1932.

Brick mason's pointing tool. JAY DARLING, assignor of one-third to Walter M. Joyce and one-third to J. Merle Darling. U. S. 1,851,497, March 29, 1932.

Making vesiculated brick, etc. JOHN J. FRED BRAND, assignor of one-third to Arthur H. Pemberton and one-third to George C. Earle. U. S. 1,851,660, March 29, 1932.

Manufacture of brick. R. DOLLE AND V. DOLLE. Brit. 369,452, March 31, 1932.

Brick. MAX SCHENKER. Fr. 708,339, Dec. 24, 1930. "Dutch" brick are made by sprinkling on the dried brick made from ordinary clay or brick clay, before or during baking, a fine powder obtained by drying and grinding products from the manufacture of KCl or slime residues composed for the greater part of clay, anhydrite, dolomite, and organic substances. (*C.A.*)

Refractories

Magnesite brick. ANON. *Brit. Clayworker*, **40** [479], 428–30 (1932).—Compositions, pressing and drying, physical properties, application of the brick, and durability of linings are discussed. R.A.H.

Manufacture of Fosalsil brick. ANON. *Engineering*, **133** [3448], 231–32 (1932).—The manufacture and composition of Fosalsil brick is described. See also *Ceram. Abs.*, **10** [3], 200 (1931). A.A.

Study of kiln marking of fireclay brick. ANON. *Brick Clay Rec.*, **80** [3], 164 (1932).—Causes and corrections are discussed. E.J.V.

Recent advances in the field of highly refractory materials. HANS TRAPP. *Metallbörse*, **21**, 1977–78, 2009–10, 2041–42, 2073–74 (1931). (*C.A.*)

Magnesium orthosilicate as a refractory. F. REINHART. *Tonind.-Ztg.*, **56** [23], 323–24 (1932).—Proposals to use magnesium orthosilicate as a refractory material are discussed. As a raw material, magnesium hydrosilicate is proposed. Means of counteracting the high iron content of this substance are suggested. W.M.C.

Sintered corundum. H. KOHL. Reprint from *Arch. tech. Messen.; Feuerfest*, **8** [2], 29 (1932).—K. discusses the differences between alundum, carbofrax, etc., and describes their manufacture in the laboratory of the Siemens Konzern according to the methods of H. Gerdien and R. Reichmann. The chemical, electrical, and thermal

properties of these materials are given. Their use as highly refractory materials is discussed. M.V.K.

Structure of sillimanite and related materials. W. H. TAYLOR. *Pottery Gas.*, **57** [658], 509 (1932).—In presenting an account of information obtained by X-ray methods as to the structure of sillimanite and certain related alumino-silicates, T. describes the structures of cyanite, sillimanite, and andalusite and indicates the importance of the variable coördination number of the aluminum ion. The relationship between sillimanite and mullite is explained on the assumption that the silicon ion and the four-coördinated aluminum ion are structurally equivalent. Information has been obtained by Roussin in an application of the X-ray powder method to the investigation of the structure of porcelain. E.J.V.

Clay mixtures for glassmelting pots. IV. J. H. PARTRIDGE, E. F. ADAMS, AND J. R. LAIT. *Pottery Gas.*, **57** [658], 509 (1932).—An attempt was made to determine the degree of solution of various clays in molten glass and to examine the quality of the glass obtained from small crucibles melted from each clay. The technique of subjecting known specimens of fireclay refractory material to the corrosive influence of batch and measuring the decrease in area seems to be a suitable method for the study of corrosion problems and gives information on the effect of the refractory on the quality of the glass and the tendency of the refractory to form pits. Siliceous clays became corroded more than aluminous ones, and close-grained, aluminous clays resisted corrosion effects to the highest degree. From tests on small crucibles of the test clay the best quality glass was obtained from the more siliceous clays. The protection of aluminous clays against corrosive influences is due to the formation of a white interlayer rich in mullite. For Part III see *Ceram. Abs.*, **10** [10], 704 (1931). E.J.V.

Refractory materials. II. ALEXANDER H. HAYES. *Blast Fur. Steel Plant*, **20** [4], 368–70 (1932).—The various transitions possible in forms of silica at different heat treatments are taken up, with mention of the volume changes undergone at each transition. Under high-alumina refractories brief but comprehensive discussions of bauxite, diaspore, sillimanite and mullite, and corundum refractories are presented. For Part I see *Ceram. Abs.*, **11** [5], 310 (1932). E.J.V.

Concentration of bauxites. I. MASLENITZKII. *Trans. All-Russ. Sci. Tech. Mining Congr., 1st Congr.*, **VIII**, 124–29 (1928).—With flotation and other methods for concentrating Tikhvin bauxites in U.S.S.R., the following results were obtained: for grade I, the Al_2O_3 : SiO_2 ratios for starting material, concentrate, and tailing were 4.3 to 4.5, 12, and 1.9, respectively; for grade II, the ratios were 9 to 45, 30, and 6.7; for grade III, 5.75, 10, and 3.0; for grade IV, 1.54, 1.84, and 1.33. (*C.A.*)

Influence of iron oxide on sintering and properties of magnesite refractories for practice. OTTO KRAUSE AND WALTER KSINSIK. *Feuerfest*, **8** [1], 6–8; [2], 21–25 (1932).—The authors investigated the action of iron oxide on the sintering of raw magnesite and on its stability at high temperatures, and the structure of magnesite blocks. A dense magnesite from Euböa with 0.13% FeO content and coarse crystalline magnesite with 2.86% FeO, 2.11% FeO, and 3.44% FeO, respectively, were investigated. The results of two analyses on these blocks are tabulated. It was found that iron oxide promotes sintering only slightly. This action is smaller than that of other oxides such as CaO, Al_2O_3, and SiO_2, but the iron oxide content present has a certain influence on the rate of the softening under pressure. The oxidizing or reducing character of the firing during manufacture has a considerable influence on the structure of magnesite refractories although, with sintering, it has a secondary significance. M.V.K.

Permeability of refractories. A. KANZ. *Arch. Wärmewirt.*, **12** [5], 140 (1931); *Refrac. Jour.*, **7** [12], 556 (1931); see also *Ceram. Abs.*, **10** [11], 783 (1931). W.M.C.

Dolomite mortar. W. MORITZ. *Tonind.-Ztg.*, **56** [19], 265–66 (1932).—This is a

review of the possibilities of using low- and high-fired dolomites in different mortars. The best means of preparing the mortars is described. W.M.C.

Composition, properties, and applications of some minerals used in the building, refractory, and ceramic industries. JOSEPH DEFORGE. *Rev. mat. constr. trav. pub.*, No. 268, pp. 1–4 *B*; No. 269, pp. 29–32 *B* (1932).—Data on the production, composition, properties, and applications of dolomite and different kinds of mica, *e.g.*, alkaline, ferruginous, and calcareous mica, and its deposits in the world, and also micaceous and refractory earths are described. Methods of manufacturing refractories and determining refractoriness are discussed in detail. M.V.K.

Expansion of refractories. ANON. *Rev. mat. constr. trav. pub.*, No. 269, pp. 75–76 (1932).—The continuous expansion of different refractories from room temperature up to the highest reached, is shown in curves. A quartz-marl brick showed a weak expansion under 300°, a partial transformation of quartz at 500 to 600°, and a large expansion at 1400°. Brick in which quartz was completely transformed have the highest expansion under 400°. Their volume remains constant at higher temperatures. The expansion of other kinds of refractories: magnesite grog, dynamidon, electrically fused silica, and artificial sillimanite are discussed. M.V.K.

Pyrochemical series of the oxides. H. SALMANG. *Z. angew. Chem.*, **44** [46], 908–12 (1931); abstracted in *Refrac. Jour.*, **8** [3], 116 (1932); for abstract see *Ceram. Abs.*, **11** [4], 275 (1932).

Analysis of refractories. L. BELLADEN AND C. F. BECCHI. Abstracted in *Refrac. Jour.*, **8** [3], 116 (1932); for abstract see *Ceram. Abs.*, **11** [4], 246 (1932). E.P.R.

Meeting of the Joint Committee on Foundry Refractories. ANON. *Bull. Amer. Ceram. Soc.*, **11** [5], 127–30 (1932).

Research in refractories. H. SALMANG AND J. KALTENBACH. Abstracted in *Refrac. Jour.*, **8** [3], 116 (1932); for abstract see *Ceram. Abs.*, **11** [3], 179 (1932). E.P.R.

Year's work in refractories research and investigations. ANON. *Gas World*, **95** [2465], 435–38 (1931); *Feuerfest*, **8** [2], 29 (1932); for abstract see *Ceram. Abs.*, **11** [4], 250 (1932). M.V.K.

Organization of scientific research of the Société du Gas de Paris. CHARLET. *Jour. usine gaz*, **56** [2], 25–27 (1932); *Feuerfest*, **8** [2], 31 (1932).—A description of the laboratory for the researches made on refractory materials in Paris is given. M.V.K.

Refractories. H. E. WHITE. Abstracted in *Refrac. Jour.*, **8** [3], 116 (1932); see also *Ceram. Abs.*, **11** [4], 246 (1932). E.P.R.

Refractories for work at high temperatures. E. RISHKEVICH. Abstracted in *Refrac. Jour.*, **8** [3], 116 (1932); for abstract see *Ceram. Abs.*, **11** [5], 310 (1932). E.P.R.

Advance in refractory field in U. S. in 1931. I. W. STEGER. *Feuerfest*, **8** [2], 17–21 (1932).—S. discusses (1) the influence of weathering on the properties of fire clay, (2) refractory brick from Mo. flint clay, (3) pressing refractories in a vacuum, (4) grain-size distribution in clay-bonded refractories, and (5) size and shape of refractories, (*a*) differences in shrinkage of clays, (*b*) influence of moisture on clays, and (*c*) influence of molding pressure. M.V.K.

Bauxite in France. II, III, and IV. V. CHARRIN. *Ind. chimique*, **18** [207], 234–37; [210], 462–65; [211], 538–41 (1931).—C. describes in detail the different bauxite deposits in France and the mining and use of bauxite. For Part I see *Ceram. Abs.*, **11** [1], 55 (1932). M.V.K.

Refractory clays in France. ANON. *Ind. chimique*, **18** [209], 445–46 (1931).—France is relatively rich in refractory earths. The deposits are listed. The average

composition of these earths is as follows: silica 46.5%, alumina 40%, and other oxides 13.5%. Methods of making refractories are described. M.V.K.

Bauxite deposits. D. COSTA. *Giorn. chim. ind. applicata*, **13** [12], 564 (1931).—Analyses of the bauxite from deposits discovered in the province of Gorizia show a low iron and a high silica content. M.V.K.

Graphite deposits of Russia. ANON. *Ind. chimique*, **18** [209], 428 (1931).—Russia possesses large deposits of graphite. The deposits near Irkutsk (Siberia) are characterized by a fine crystalline structure, are poor in volatile sulphur, and contain about 63.5% carbon. The graphite from the deposits on the river Kureika contains about 90% carbon and is used for the manufacture of electrodes. Other deposits are much poorer in carbon (8 to 10%) but a process has been devised by means of which the carbon is concentrated up to 90%. The deposits of graphite on the Amour River are enormous but have not yet been mined; the same is true of Ukrainian graphite. Data on the production are given. M.V.K.

Glasshouse pots for melting English crystal glass: an agreed specification. W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **15** [60], 95–98 (1931).—The specification for the clay mixture for making the pots includes (1) two standards depending on the percentage of alumina content as follows, (*a*) 20–23 and (*b*) 24–27 (the alumina content is a mixture of clay and grog calculated on the basis of fired material), (2) the iron oxide not to exceed 2.5%, (3) raw clays ground to pass 12-mesh and at least 50% through 30-mesh sieve, (4) thorough tempering of the mixture before use, and (5) grog (all through 12-mesh) to be 20 to 25% of total mixture. The grog is to be prepared from the same clay or clay mixture as in (1) and (3), fired to about 1250°C (cones 7 to 8). Under control of specifications chemical analysis of clay is to be supplied by pot manufacturers, samples of both clay and grog for pots are to be supplied on request, and both glass and pot manufacturer are to keep records on the manufacture and use of the pots. Typical records for both are given in detail. G.R.S.

Thermal conductivity of low-temperature insulators. N. H. CHAMBERLAIN. *Chem. & Ind.*, **51** [11], 89–91 (1932); for abstract see *Ceram. Abs.*, **11** [5], 307 (1932). G.R.S.

Apparatus for testing heat-insulating brick. T. H. BLAKELEY AND J. W. COBB. *Chem. & Ind.*, **51** [11], 83–89 (1932).—The lower brick surface was maintained at the higher temperature; the heat conducted being measured by the heat loss from a blackened slab of metal placed on the upper brick surface and exposed to the air. Results are given in tables and curves. G.R.S.

Devices for applying refractory materials on the interior walls of industrial kilns. HARRAEUS. *Glashütte*, **62** [13], 217–18 (1932).—H. describes pressing, blowing, and catapulting apparatus for repairing refractory linings of industrial kilns. M.V.K.

Repairing furnaces with unfired material. A. TORGGLER. *Glashütte*, **62** [5], 75–76 (1932).—T. discusses the destruction of refractory linings in glass furnaces and describes methods used in France and Italy to avoid it. Repairing the destroyed refractory bed is very difficult when fired refractories are used. In France and Italy unfired brick are used. These brick are made of a grog clay mass with additions of quartz powder which expands during firing and compensates for the shrinking of the clay. M.V.K.

Furnace design and refractories. ANON. *Ceram. Ind.*, **18** [4], 264 (1932).—The Deutsche Gold and Silber Scheideanstalt of Germany (J. Goebel & Co., New York City, American representatives) has developed a furnace, "Degussa 2000," to reach close to 3800°F through the use of the principles of surface combustion. Together with this furnace special refractories have been developed to withstand the high temperatures. The furnace is described in detail. The fuel used is gas and air and a temperature of 2800°F may be reached in approximately 5 min. in a furnace of this type having a

working space of 12 cu. in. A furnace of this type having a working volume of 5 cu. ft. can be fired to a temperature of 3150°F. A series of practically pure oxide refractories was developed. Illustrated. W.W.M.

Development in furnaces. BABCOCK AND WILCOX CO. *Rock Prod.*, **35** [7], 80 (1932).—The development of a water-cooled furnace-wall construction designated as the Bailey "stud tube wall" is announced by the Babcock and Wilcox Co., New York, N. Y. The construction of the wall is described. Illustrated. W.W.M.

BOOK AND BULLETIN

Testing of Refractory Materials. L. LITINSKY. Reviewed in *Engineering*, **131**, 159 (1931); see also *Ceram. Abs.*, **10** [9], 646 (1931). A.A.

Kiln marking of fireclay brick. S. M. KIER. Amer. Refractories Inst., *Tech. Bull.*, No. 30, 4 pp. (1931).—Two important types are deformation due to the load carried and to secondary expansion. Very slow heating (91.5 hr.) to 2462°F gives poorer brick than rapid firing (4.5 hr.) to the same temperature. The best brick are produced by firing at a sufficiently slow rate and at a temperature high enough to eliminate shrinkage. (*C.A.*)

PATENTS

Making refractory containing silicon carbide. EDWIN B. FORSE AND CHARLES F. GEIGER. U. S. 1,849,289, March 15, 1932.

Furnace arch. SIDNEY THURSBY, assignor to H. Windsor & Co., Ltd. U. S. 1,849,558, March 15, 1932.

Preparing dense mix for refractories. RUSSELL P. HEUER, assignor to General Refractories Co. U. S. 1,851,181, March 29, 1932.

Synthetic spinel. EMANUEL ANCOT, assignor to Wiede's Carbidwerk Freyung mit beschränkter Haftung. U. S. 1,852,097, April 5, 1932. A spinel base mixture of alumina and magnesia of about 600 parts with approximately 10 parts of an iron compound, 0.5 part of a beryllium oxide, and 0.2 part of titanium fluoride, all parts being by weight.

Manufacture of pure aluminum oxide. YEIICHI TATSUMI, TAKISABURO IKEBE, AND KOJIRO OKAZAKI, assignors to Mitsui Mining Co., Ltd. U. S. 1,853,097, April 12, 1932.

Basic refractory brick, etc. C. S. GARNETT AND GARNETT BASIC REFRACTORIES, LTD. Brit. 368,798, March 23, 1932.

Saggers for use in firing ceramic ware. J. WOOLFSON. Brit. 368,931, March 23, 1932.

Recovery of alumina from coal products. ELECTRIC SMELTING & ALUMINUM CO. Brit. 369,268, March 31, 1932.

Manufacture of silica brick. F. H. BROOKE. Brit. 369,312, March 31, 1932.

Repairing retorts, etc. T. FRASER. Brit. 369,365, March 31, 1932.

Air-cooled furnace walls. MORGAN CRUCIBLE CO., LTD., AND J. WALKER. Brit. 369,413, March 31, 1932.

Synthetic spinel. I. G. FARBENIND. A.-G. Fr. 687,661, Jan. 3, 1930. A synthetic spinel having an aquamarine color in daylight and artificial light is made by adding 0.3% of TiO_2 to the starting mixture of Al_2O_3 and MgO. Other substances producing this color may be added as well. See following abstract. (*C.A.*)

Synthetic spinel. I. G. FARBENIND. A.-G. Ger. 535,066, May 1, 1930. Spinel resembling alexandrite is prepared by fusing a mixture of Al_2O_3 and MgO containing a little Cr_2O_3 and Co. A suitable mixture contains Al_2O_3 85, MgO 15, Cr_2O_3 1, and Co 0.06 parts. (*C.A.*)

Synthetic spinel. I. G. FARBENIND. A.-G. Ger. 535,251, April 30, 1930. Violet

spinel is prepared by fusing a mixture of Al_2O_3 and MgO with a little Fe and Co or their compounds. A suitable mixture contains Al_2O_3 84, MgO 16, Fe 1.5, and Co 0.005 parts. (*C.A.*)

Alumina. THE ELECTRIC SMELTING & ALUMINUM CO. Fr. 708,027, Dec. 18, 1930. Silico-aluminous materials are treated for the recovery of Al_2O_3 by mixing them with $CaCO_3$ or an alkali carbonate and fritting to obtain a product containing a greater number of molecules of alkali aluminate than molecules of di-Ca silicate. The aluminate is extracted from the fritted material. (*C.A.*)

Refractory brick. JOHANN A. R. LÖSSNITZ. Fr. 708,826, Jan. 3, 1931. Refractory brick are made of grains of leaning material of practically uniform size to which are added fine grains of such a size and quantity that they fill the interstices between the large grains without separating them from one another. The remaining interstices are filled by the binding agent in a very fine state of division, to which may be added finely powdered leaning material. (*C.A.*)

Refractory brick. WILHELM H. DANIELS. Fr. 709,692, Jan. 20, 1931. Use is made of impure or imperfectly calcined magnesite, to which, besides the usual binding agent, is added 1 to 3% of chrome ore which annuls the destructive effect on the structure of the brick of the impurities. (*C.A.*)

Alumina. GIAN A. BLANC. Fr. 709,914, Jan. 24, 1931. Al_2O_3 is produced from hydrated $Al(NO_3)_3$ with minimum formation of lower oxides of N, by heating the nitrate in several steps, first to eliminate the greater part of the water of crystallization and HNO_3 at not above 150°, then to 250° to remove a further amount of water and acid, and finally to above 250° to remove the last traces. (*C.A.*)

Refractory materials. HARTFORD-EMPIRE CO. Fr. 709,978, Jan. 26, 1931. Ceramic refractory materials are made from a mixture containing a kaolin and a clay, having, respectively, the characteristics of Georgia and Klondike kaolin and G_1 clay of Georgia and a small quantity of feldspar. The kaolin is largely in excess of the clay. (*C.A.*)

Refractory articles. ARTHUR SPRENGER. Ger. 535,223, Oct. 11, 1927. Refractory articles are made from the slag obtained in the manufacture of Fe-Cr alloys from Cr ores. An amount of C insufficient for complete reduction of the ore is used so that a chromiferous slag is obtained which may be poured directly into molds. (*C.A.*)

Terra Cotta

Formation of blisters in roofing tile. J. ZENTZ. *Tonind.-Ztg.*, **56** [2], 17–18 (1932).—The paper by Schuen (for abstract see *Ceram. Abs.*, **11** [1], 42 (1932)) refers to the formation of blisters only on stoneware bodies. Similar faults are encountered with roofing tile. The main reasons for the formation of blisters are bad preparation of the raw materials and the retention of air inside the body during the pressing process. W.M.C.

Manufacture and use of terra cottas. W. HENZE. *Tonind.-Ztg.*, **56** [24], 333–35 (1932).—Different types of terra cottas are reviewed. W.M.C.

Brick resistant to acids. F. NIEBLING. *Schweiz. Tonwaren-Ind.*, **34** [8], 117 (1931); *Rev. mat. constr. trav. pub.*, No. 269, pp. 27–29*B* (1932).—Stoneware is highly resistant to the corrosive action of acids and alkalis of all natures and every concentration. Only hydrofluoric acid attacks silicates. Siliceous mortars are much more resistant than bituminous mortars and are used for temperatures over 80°. They are composed of crushed quartz and soluble silicate. Large plates or brick can be produced with mixtures containing coarse grains of grog bonded with plastic clay to impervious structure. Service requirements are given. M.V.K.

PATENT

Making structural material. HARRY C. PEFFER, RICHARD L. HARRISON, AND DAVID E. ROSS, assignors to Rostone, Inc. U. S. 1,852,672, April 5, 1932. The process of producing an artificial structural material possessing high compressive and tensile strength and resistant to attack by ordinary chemical reagents consisting in intimately mixing an alkaline earth base, a finely ground material composed principally of hydrated aluminosilicic acid and water, and subjecting the mass to heat in a closed chamber in which sufficient water vapor is maintained to prevent evaporation of the essential reacting water in the mass until the mass is transformed into the material.

White Wares

Pottery from the air. ANON. *Popular Sci.*, **120** [5], 28 (1932).—Ultra-fine clay powder collected in a dust catcher at a Catalina Island quarry is excellent for pottery and tile and hence the products are called "pottery from the air." Illustrated. E.J.V.

Placing material for bone china. BERNARD MOORE. *Pottery Gaz.*, **57** [658], 510–12 (1932).—Due to the decomposition of part of the surface of bone china during firing where flint is used as a placing material, experiments with different kinds of placing materials were conducted. The mixture recommended as a substitute for placing flint was 75% calcined bone ash and 25% calcined alumina. This mixture gives powder which makes a good bed; it is much less dusty than either silica or alumina, and can be used over and over again with no appreciable loss of P_2O_5. Experiments show that bone china placed in this material will stand an extra cone of firing without decomposing, and the properly prepared, well-calcined material drops off the fired china. E.J.V.

Defects in glazed whiteware objects produced by quartz sand in the mass. P. P. BUDNIKOFF AND M. I. SOLOMONOV. *Sprechsaal*, **65** [12], 218–19 (1932); for abstract see *Ceram. Abs.*, **11** [2], 74 (1932). M.V.K.

Defects in pottery bodies and glazes. ANON. *Ceram. Ind.*, **18** [4], 242–45 (1932).—Some of the common problems encountered in the production of pottery ware are discussed and practical suggestions are offered to correct blistering, pinholing, crawling, and crazing. W.W.M.

Mechanical wear of porcelain hotel dinnerware. FRIEDRICH GAREIS. *Ber. deut. keram. Ges.*, **12** [12], 609–18 (1931).—A year's observation in hotels and in laboratories gave the following conclusions: The loss in service is due to (1) mechanical influences, (2) chemical influences, and (3) unsuitable shape. Loss in service develops in angular and raised pieces. Flat ware suffers the greatest destructive mechanical influences. The unglazed foot, which is harder, and the overglaze colors increase the mechanical wear. The mechanical wear increases both for too high and too low an overglaze firing temperature and is lowest only at a definite optimum temperature which, for the cases investigated, was determined as 890°. Illustrated. E.J.V.

High-voltage substation insulators. ANON. *Elec. Rev.*, **110** [2833], 375 (1932).—The development of radial cracks in high-voltage insulators under modern conditions can be traced to the expansion of cement joints in "aging." In insulators of the pedestal type, the shells and metal parts are commonly joined by long courses of cement enclosed within the porcelain, and many manufacturers have inserted elastic layers, *e.g.*, bitumastic paint (which reduces the mechanical strength), and have diluted the cement with 2 or 3 parts of sand or ground porcelain to lessen the per cent expansion. On the

Continent the internal cement layers have been eliminated for the past 5 or 6 years, the insulators consisting of porcelain cylinders carrying rain sheds with metal flanges cemented outside at the top and bottom. The elasticity of the flanges takes up any expansion of the cement. Flash-over on the inside of the cylinder is prevented by a horizontal porcelain plate which is baked in one piece with the outer walls. This bridge is now placed well below the flange which removes it from the intense electric field produced by the edge of the flange. E.P.R.

Porcelain insulators. W. E. WILLIAMS. *Electrician*, **107**, 729–30 (1931).—An electrolytic method is described that permits the direct determination of electric stress lines in porcelain; it appears capable of extension to many problems involving media of different dielectric constants or magnetic permeabilities. The media are represented by jellies of different conductivities. The experimental arrangement is shown by a graph as are fields of the suspension-type and of the pin-type insulators. (*C.A.*)

Variety of products. JAMES M. BONNER, JR. *Ceram. Ind.*, **18** [4], 249 (1932).—The Eljer-California Co., Los Angeles, Calif., has made an effort to meet the demands of the changing times by developing new products. Less than ten years old, the company has doubled its kiln capacity and tripled its floor space. Among the new products is a vitreous china vat 36 in. high and 41 in. in diameter, glazed inside and out. A ton of dry plaster was used in the mold and 620 lb. of slip were required to cast the piece. W.W.M.

Glazed sanitary ware. ANON. *Brit. Clayworker*, **40** [479], 424–26 (1932).—The manufacture of sanitary ware from raw materials, and their casting and firing are discussed. R.A.H.

BULLETIN

An investigation of the properties of some feldspars. C. W. PARMELEE AND T. N. MCVAY. Price 30¢. Univ. of Ill. Eng. Expt. Sta. *Bull.*, No. 233, 50 pp. (1931).—(*A*) *Scope.* The investigation has included the following studies: (1) petrographic examinations, (2) chemical analyses, (3) pyrometric cone equivalents, (4) screen analyses, (5) true specific gravity, (6) free quartz by the Klein and Booze microscope method, (7) p_H values of feldspars in water suspension, (8) possible feldspar-flint eutectic, (9) porosities of various bodies containing feldspars, (10) volume shrinkage of feldspar bodies, (11) softening range of electrical porcelain bodies under torsion at high temperature, (12) moduli of rupture of the bodies, (13) petrographic examinations of the bodies, (14) thermal expansion of feldspars fused at various cone temperatures, and (15) thermal expansion of feldspar-flint mixtures. (*B*) *Data.* Results on the tests outlined are reported. (*C*) *Conclusions.* The soda and the potash feldspars are distinguished by various characteristic properties. Among these are specific gravity, refractoriness, influence upon viscosity, and therefore the rate of the maturing of bodies as indicated by changes in porosity and shrinkages, and the strength of the bodies. Neither the Klein and Booze method nor the specific gravity determinations served to differentiate safely between the two types of feldspars. Feldspars of intermediate soda-potash content have a longer range of temperature change with less volume change than is the case with either the pure potash or soda feldspars. This useful characteristic is conferred upon body mixtures in which such intermediate feldspars are used and such compositions are given a longer "firing range." By the suitable selection of feldspars it is possible to produce with American ball clays bodies having the valuable firing range peculiar to some English clays. The change in the feldspar particles in body mixtures is characteristic and definite for each range of temperature. The conduct of casting slips containing feldspar may be notably influenced by the degree of "solution" of the feldspar used. No evidence of a feldspar-silica deformation eutectic was found within the

range of compositions investigated, and the influence of additions of silica upon the thermal expansion was slight but well defined. A.A.

PATENTS

Making ceramic articles. LEWIS H. BOWN, assignor to Buffalo Pottery Co. U. S. 1,849,272, March 15, 1932.

Displaying tile. CLARK A. WHITCOMB. U. S. 1,850,647, March 22, 1932.

Removing excess material in shaping pottery ware. WILLIAM J. MILLER. U. S. 1,850,939, March 22, 1932.

High-tension insulator. ROBERT M. JOHNSTON AND ALEXANDER MCLACHLAN. U. S. 1,851,671, March 29, 1932.

Manufacture of earthenware covers or lids for teapots, etc. W. COULTER AND H. F. WOOD. Brit. 368,148, March 9, 1932.

Drying plant for earthenware. PAUL THOR. Ger. 534,619, Jan. 13, 1929. (*C.A.*)

Equipment and Apparatus

Mechanical inspector. ANON. *N. Y. Herald Tribune; Nat. Glass Budget*, **47** [47], 22 (1932).—A mechanical inspector that will spot a defect that is less than one ten-thousandth of a second and record it has been developed by Floyd Firestone for the Dept. of Engineering at the Univ. of Mich. The object to be examined is held in a clamp and revolved. As it revolves it also passes under the lens of a microscope; the light from the metal surface passes through the microscope to a diaphragm which takes the place of the eye-piece. This beam of light falls upon a photoelectric or selenium cell. If a flaw or crack appears on the product being viewed by the microscope lens, it at once alters the quantity of light from this area, and this is noted by the photoelectric cell which shows a change in the current passing through it. The cell will react to a change in one ten-thousandth of a second, but this is too short to operate relay switches to turn the faulty material into discard, so a "memory" had to be devised. This took the form of a gas-filled radio tube which came into action when the fluctuating current from the photoelectric cell was amplified and passed through it. Current from this tube actuates a magnet which sets the apparatus for automatic discard. E.P.R.

"Pyrotere," six-color multiple recorder. A. JOURDAIN. *Céramique*, **35** [526], 1–7 (1932).—Conflicting requirements of range and sensitivity in controlling the temperatures in a tunnel kiln were met by opposing the electromotive force from the couples by a regulated voltage and recording the difference on a 6-point recorder. In this way 2 degrees change in temperature caused a deflection of one millimeter. The installation is described in detail. A.E.R.W.

Light-sensitive tube for accurately controlling cement mixtures. ANON. *Pit & Quarry*, **24** [1], 66 (1932).—One of the relatively recent uses of the photoelectric tube is in the proportioning of concrete aggregates, where it is adapted to the control of scales and weighing machines. It is highly sensitive and entirely eliminates the necessity of using mechanical contacts which, by reason of their resistance to motion, would affect the scale accuracy seriously. E.P.R.

Grinding plant research. II. Tests of cement clinker grinding mills. III. Method of obtaining reference curve and additional clinker grinding tests. WILLIAM GILBERT. *Rock Prod.*, **35** [4], 27–31; [6], 32–35 (1932).—G. shows how the power reference curve was obtained and gives additional test results with a table of various test data. A comparison is made of these results. For Part I see *Ceram. Abs.*, **11** [2], 123 (1932). W.W.M.

Separator for determining cement fineness. T. S. SMIDTH AND CO. *Rock Prod.*, **35** [6], 71 (1932).—An apparatus for determining the fineness of cements below the sieve limits by air separation methods is described and illustrated. W.W.M.

Mixer for ceramic materials. LANCASTER IRON WORKS, INC. *Ceram. Ind.*, **18** [4], 257–64 (1932).—A new device known as the Eirich patent counter-current rapid batch mixer is applicable to mixing problems in the pottery, glass, enamel, refractories, and other clay industries. The apparatus and its operation are described. W.W.M.

Chromium plating the clay flow. ANON. *Clay-Worker*, **97** [3], 156–57 (1932).—Practiced methods of preparing dies for resistance to abrasion by clay, the advantages of chromium plating, and methods of chromium plating are discussed. E.J.V.

Lubricant for ball bearings. PAUL J. ANDERSON. *Maintenance Eng.*, **90** [4], 170–71 (1932).—The dangers of over- and under-lubrication for ball bearings are explained. Illustrated by charts. J.L.G.

Lubricating systems. Filtering devices. FRED H. LOW. *Maintenance Eng.*, **90** [4], 160–62 (1932).—Various types of oil-filtering and purifying devices are described. Illustrated. See also *Ceram. Abs.*, **11** [2], 123; [4], 256 (1932). J.L.G.

Bottle mold machine. ANON. *Amer. Glass Rev.*, **51** [26], 11–12 (1932).—Irregular contours and shapes, as well as regular shapes are machined automatically on the new Monarch-Keller form turning machine with error less than 0.001 inch. After the lathe is loaded and the template attached, the directional buttons on the control board are pressed. The tracer moves in toward the template until contact is made and then follows its contour exactly. E.P.R.

Air thermoregulator. J. B. M. COPPOCK, J. COLVIN, AND J. HUME. *Chem. & Ind.*, **51** [7], 140 (1932).—The advantages of the thermoregulator are (1) by suitable choice of the bulb material the regulator may be used over a wide range of temperatures, (2) changes in atmospheric pressure do not alter the temperature for which it is set, and (3) the annular mercury column compensates for variations in room temperature. A diagram illustrates the principle of the apparatus and a detailed description is given of its operation. At about 400°C the regulator was found to control a furnace temperature to within ±0.75°C of the setting temperature. Increasing the capacity of the bulb would improve the sensitivity of the regulator. G.R.S.

The electric furnace in the patent office. JOSEPH ROSSMAN. *Trans. Electrochem. Soc.* (Preprint), **61**, 8 pp. (1932).—No separate class existed in the U. S. Patent Office for electric furnaces until 1931 when about 2000 patents relating to the electric furnace were gathered together and classified into the Official Class 13, "Electric Furnaces." This paper presents an outline and definition of this class and its subclasses on account of its practical interest and value to those interested in the commercial development of the electric furnace. (*C.A.*)

Gas sampling device for boiler gases. H. F. MULLIKIN. *Mech. World*, **91** [2357], 230 (1932).—A flue-gas sample from a boiler analyzed by means of the conventional Orsat is accurate providing a representative sample has been obtained. A sampler in which all the individual gas samples may be mixed and a single analysis made is illustrated. E.P.R.

Portable apparatus for complete technical gas analysis. E. OTT. *Gas Wasserfach*, **74**, 970–71 (1931).—A convenient portable form of gas analysis apparatus is shown, and operating details are given. An NCT-3 steel tube may be used to hold the copper oxide for combustion analyses which are carried out at 300° (thermometer at side of tube) for hydrogen and at a bright red heat for CH_4 and C_2H_6. A method of preparing suspensions of I_2O_5 in fuming sulphuric acid is given. (*C.A.*)

Automatic recorder for sulphur acids in flue gases. J. J. FOX AND L. G. GROVES.

Chem. & Ind., **51** [2], 7–10 (1932).—The method consists in (1) the automatic absorption by scrubbing of a continuous stream of flue gas with a dilute solution of hydrogen peroxide, whereby sulphur dioxide is oxidized to sulphuric acid; (2) determination of the altered p_H by means of a glass electrode; (3) amplification of the changing voltage by means of valves; and (4) recording the result of a galvanometer deflection automatically on a chart. A number of diagrams of the apparatus are given. G.R.S.

New British standard for testing sieves. EDMUND SHAW. *Rock Prod.*, **35** [6], 17 (1932).—S. compares the new British Standard testing sieves with the standard sieve series of the U. S. Bureau of Standards. The two series are nearly the same except for several of the coarser sieves. See also *Ceram. Abs.*, **10** [1], 54 (1931). W.W.M.

British dust collector. ANON. *Crushing and Grinding* [British]; *Rock Prod.*, **35** [6], 29 (1932).—A dust collector with some new features is described and illustrated. It is of the cloth-bag type with apparatus for cleaning automatically at stated periods. W.W.M.

Basic law of the wet- and dry-bulb hygrometer at temperatures from 40 to 100°C. G. H. AWBERY AND E. G. GRIFFITHS. *Engineering*, **133** [3445], 113–15 (1932). A.A.

Carbon brushes. J. S. MARCUS. *Maintenance Eng.*, **90** [4], 166–68 (1932).—The theory of commutation, the method of setting brushes to insure proper contact, the causes of sparking, and a method of checking interpole compensation are explained. Illustrated by diagrams. J.L.G.

Double-disk sanding machine. ANON. *Engineering*, **133** [3447], 174 (1932). A.A.

Eliminating slip in vertical belt drives. ANON. *Clay-Worker*, **97** [3], 148 (1932).—The smallest angle from the vertical that will overcome the sagging of the belt is given. Illustrated. E.J.V.

Belt conveyer theory and practice. II. Power required. G. F. DODGE. *Rock Prod.*, **35** [7], 78–79 (1932).—D. gives detailed and illustrated methods for computing the power requirements of belt conveyers. For Part I see *Ceram. Abs.*, **11** [2], 122 (1932). W.W.M.

The future of electrical control. H. D. JAMES. *Maintenance Eng.*, **90** [4], 156–59 (1932).—Electron tubes which respond to a difference in sound, light, color, frequency, and other variables open new fields to electrical control. Illustrated. J.L.G.

Thermal and electrical properties of graphite. ANON. *Ind. chimique*, **18** [210], 521 (1931).—The conductivity of graphite is surpassed only by silver, copper, gold, aluminum, and magnesium and hence it is interesting for kiln electrodes. The conductivity of graphite agglomerates increases with increasing temperature while that of graphite decreases like that of metals. The electric resistance of graphite is practically constant up to 2000°C. The connecting of electrodes is easy with graphite because ordinary electrodes can not be welded without great precaution. M.V.K.

Clay feeders. ALBERTO PELLACINI. *Corriere ceram.*, **13** [2], 77–79 (1932).—The operation of different types and sizes of clay feeders is explained. M.V.K.

Science and practice of drying. XII. ANON. *Brit. Clayworker*, **40** [479], 418–21 (1932).—The tendency of hot air to travel unequally in some chamber driers, attempts made to overcome this drawback, and various methods of obtaining air circulation in driers are discussed and the Welwyn drier is described. R.A.H.

Practice of drying. ANON. *Rev. mat. constr. trav. pub.*, No. 267, pp. 229–30*B* (1931).—A discussion of the development of drying installations is given. The conditions of primary importance for a good drying installation are (1) the possibility of regulating the quantity of air introduced, and (2) regulation of temperature. The expansion, shrinkage, and phenomenon of drying are described in detail. M.V.K.

Filter pressing and drying. L. A. MITCHELL. *Pottery Gas.*, **57** [657], 349–52 (1932).—After discussing the older method of preparing clay by filter pressing and drying and showing the disadvantages of this method, M. states that the problem of continuous separation of solids from a liquid, combined with a continuous drying system, has been solved in the combined automatic filter and drier. The working principles of this continuous rotary vacuum filter and drier are described. Operating data on different sizes of these filters are presented. The advantages are as follows: (1) absence of scraper blades, (2) continuous discharge, (3) use of a thin finely woven fabric for the filtering medium, (4) no necessity of washing the filter cloth after each rotation to prevent sliming-up, and (5) no blow-back required on the filter cells to lift off the cake. E.J.V.

BULLETIN

Graphite as a lubricant. ANON. *Nat. Glass Budget*, **47** [47], 7 (1932).—A bulletin published by the Acheson Oildag Co., manufacturers of colloidal graphite products, contains some pertinent facts about graphite and its use in the glass manufacturing industry. E.P.R.

PATENTS

Brick handling truck. ROBERT A. FONTAINE. U. S. 1,849,424, March 15, 1932.

Surfacing device for glass and ceramic articles. CHARLES HEUZE. U. S. 1,849,925, March 15, 1932.

Material abrasion tester. FRANZ D. ABBOTT, assignor to Firestone Tire & Rubber Co. U. S. 1,850,056, March 15, 1932.

Grinding muller roller. RALPH E. RITCHIE, assignor to Chambers Brothers Co. U. S. 1,852,435, April 5, 1932.

Mud gun. AUGUST F. GIESE, JR. 1,852,559, and 1,852,560, April 5, 1932.

Mud gun carriage. AUGUST F. GIESE, JR. U. S. 1,852,561, April 5, 1932.

Clay gun. AUGUST F. GIESE, JR. U. S. 1,852,562, and 1,852,564, April 5, 1932.

Clay gun carriage and locking means. AUGUST F. GIESE, JR. U. S. 1,852,563, April 5, 1932.

Lubrication and protection for clay gun screw drives. AUGUST F. GIESE, JR. U. S. 1,852,565, April 5, 1932.

Brick mold. DAVID J. STRICKLAND, assignor to Henry Powell Ramsdell. U. S. 1,854,079, April 12, 1932.

Estimating the insulation of buildings. A. F. DUFTON AND H. E. BECKETT. Brit. 367,123, Feb. 24, 1932.

Electrical indicating, recording, and integrating instruments. LEA RECORDER CO., LTD., AND C. F. CLIFFORD. Brit. 367,399, March 2, 1932.

Dry-molding ceramic materials. PORZELLANFABRIK KAHLA ZWEIGNIEDERLASSUNG FREIBERG. Brit. 367,828, March 9, 1932.

Plant for drying ceramic ware, etc. K. LUHMANN. Brit. 367,846, March 9, 1932.

Plant for cleaning or treating glaze used in the manufacture of pottery, etc. W. PODMORE AND O. G. COLLIER. Brit. 367,849, March 9, 1932.

Microscopes for use with hardness-testing machines. H. GREEN AND V. I. N. WILLIAMS. Brit. 368,038, March 9, 1932.

Automatically delivering powdered substances to the dies of a press. W. COULTER AND H. F. WOOD. Brit. 368,146, March 9, 1932.

Brick-molding machines. L. WALKER. Brit. 368,984, March 23, 1932.

Molding tile, etc. A. G. SHARPLES. Brit. 369,006, March 23, 1932.

Determining the volume of granular substances, etc. A. HANIQUE. Brit. 369,458, March 31, 1932.

Mold with removable side walls for ceramic masses, etc. EMILE V. PREUSS. Ger. 536,161, July 18, 1928. (*C.A.*)

Drying plant for ceramic objects. HERMANN HAAS. Ger. 536,972, Dec. 20, 1930. The plant has warming and drying chambers. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Work and functions of the technical service during 1931. V. BODIN. *Ceramique*, **35** [527], 30–34 (1932).—Firing data are given for seven continuous kilns firing brick and tile by the technical service of the French Society of Ceramic Manufacturers. A comparison of firing curves and temperature distribution showed marked dissimilarities and indicated the reason for the excessive consumption of fuel at some of the plants. A.E.R.W.

Estimating kiln capacity. ANON. *Brit. Clayworker*, **40** [479], 421 (1932).—The output of a continuous kiln in regular use, apart from irregularities due to variations in draft, in supplies of brick, or in the operation of the kiln, depends primarily on the rate at which the fire travels forward. The rate of fire travel is shown in the following table based on European practice:

Effective length (ft.)	Less than 220	220–270	270–400	More than 400
Daily fire travel (ft.)	23	30	37	50

The capacity of a kiln is usually calculated by deducting $^1/_8$ of the height, to allow for the curve of the arch, and by multiplying this "reduced height" by the width and then by the length of the kiln. R.A.H.

Cause of low output. ANON. *Brit. Clayworker*, **40** [479], 423 (1932).—The low output of many continuous kilns is due to faulty design and poor construction. These defects can be overcome by (1) making up all leakages and using mechanical stokers to the best advantage; (2) raising the height of the chimney by 6 ft. or more; (3) draining a wet foundation which is always the cause of slow fire travel in the lower part of the kiln; and (4) separating the steam produced during the "smoking" or drying-off stage from the chimney and using a fan to create the draft at this stage. R.A.H.

Stokers on periodic kilns. ANON. *Brick Clay Rec.*, **80** [3], 145–46 (1932).—Gates kiln stokers are being used at Illinois Clay Products Co. plant near Joliet with economy and improved products. A fuel saving of 10 to 20% was made by using ten stokers on a kiln and screened coal. Illustrated. E.J.V.

Flat-topped brick kilns. ANON. *Corriere ceram.*, **13** [2], 57 (1932).—The first flat-topped ceramic kiln was constructed by Ragoney in 1925. The principal advantages are (1) thinner kiln walls, (2) impossibility of displacement of the roof, (3) increased kiln capacity, (4) more regular operation of the kiln, and (5) lower cost of construction and repair. M.V.K.

Note on Leeds and Northrup pyrometers and their application to a Hoffman kiln. C. FAURE. *Céramique*, **35** [527], 25–29 (1932).—The principle and construction of a Leeds and Northrup (potentiometric) pyrometer and its application to a Hoffman kiln are described. A.E.R.W.

Causes and consequences of poorly conducted firing. ANON. *Corriere ceram.*, **13** [2], 57 (1932).—Poor firing may be caused by (1) incorrect dimensions of the kiln, (2) errors in the dimensions of the chimney, (3) errors in the construction of smoke

flues, (4) poor insulation of the masonry, and (5) a poorly constructed and badly insulated foundation. The consequences of poorly conducted firing include the following: (1) insufficient output of the kiln and an excessive fuel consumption, and (2) ugly appearance of the fired product which often becomes covered with a white coat. Technical courses have been organized by the Industrial Union and Ceramic Society of Czechoslovakia to eliminate these faults. M.V.K.

Mechanical firing of downdraft kilns. ANON. *Brit. Clayworker*, **40** [477], 372–77 (1932); for abstract see article by Rice and Faller, *Ceram. Abs.*, **10** [12], 842 (1931). R.A.H.

Dressler small muffle kiln. SWINDELL-DRESSLER CORP. *Ceram. Ind.*, **18** [4], 264–66 (1932).—A tunnel kiln designed for the Trent Tile Co., embodying a number of new features, is described in detail. W.W.M.

Saggerless firing of porcelain in small tunnel kiln. NATIONAL PORCELAIN CO. *Ceram. Ind.*, **18** [4], 233–34 (1932).—An 85-ft. oil-fired tunnel kiln uses only 2 burners and displaces 4 periodic kilns. No saggers are used and the trucks hold a load 4 ft. x 2 ft. x 1 ft. 4½ in. The complete firing cycle is 20 hr. and the ware can be fired to cones 10 or 12. Oil consumption averages 12 gal. per hr. W.W.M.

Round tunnel kiln. HARROP CERAMIC SERVICE CO. *Ceram. Ind.*, **18** [4], 266 (1932).—The Harrop Ceramic Service Co. is building a revolving ring-type tunnel kiln, 60 ft. in diameter, for the Steubenville Pottery Co. It is an adaptation of the straight-line car tunnel kiln. W.W.M.

Tunnel kilns. RENÉ SYLVANY. *Rev. mat. constr. trav. pub.*, No. 267, pp. 221–25*B* (1931); No. 268, pp. 5–9*B*; No. 269, pp. 23–27*B* (1932); for abstract see *Ceram. Abs.*, **11** [3], 197 (1932). M.V.K.

Amount of air for water-smoking in the ring kiln. P. THOR. *Tonind.-Ztg.*, **56** [20], 277–78; [24], 335–36 (1932).—Several ring kilns in Germany are described and their efficiency is discussed. A comprehensive table is given on the dimensions of those parts of the kilns which are connected with the water-smoking process. The actual output of different kilns is given. W.M.C.

Modern construction and operation of Siemens-Martin kilns. E. DIEPSCHLAG. *Z. Ver. deut. Ing.*, **75** [32], 1005–12 (1931); *Glastech. Ber.*, **10** [2], 103 (1932).—D. describes in detail the operation of a Siemens-Martin kiln and compares it to that of a glass tank because of the great similarity in their operation. The problem of the building of kilns for melting steel is at present a problem of refractory materials. M.V.K.

Large resistance furnaces. G. W. B. ELECTRIC FURNACES, LTD. *Elec. Rev.*, **110** [2833], 386 (1932).—Three large resistance furnaces have been provided for the Banbury works of the Northern Aluminum Co., Ltd. Two of these are among the largest furnaces of the type installed in this country and have chambers measuring 14 ft. long, 7 feet wide, and 5 ft. high to the spring of their arched roofs. The chambers of the furnaces are lined with Wild-Barfield tunnel brick which house thick rod elements in a patent hairpin form, the ends of each hairpin being thickened to four times the element area where they pass through the insulation at the back of the furnace to avoid hot connections and loss of power. E.P.R.

Progress in blast-furnace practice. ANON. *Steel; Mech. World*, **90** [2343], 519 (1931).—A development in blast-furnace practice is the use of a refractory-lined blowpipe for conducting the blast into the furnace where hot-blast temperatures in the vicinity of 1500°F are carried. The refractory blocks, which have a low thermal conductivity, are placed in their correct position in the mold before the blowpipe is cast. A test conducted on a steelworks stack using refractory-lined pipes revealed that the hot-blast temperature at the face of the tuyères was 28° higher than when unlined cast-

iron blowpipes were used on the same furnace. The lining prevents warpage and cracking. E.P.R.

Electric ceramic furnace. ANON. *Ceram. Ind.*, **18** [4], 234 (1932).—The Imperial College of Science and Technology, London, is demonstrating a high-temperature electric furnace for ceramics. The old-type refractory resistor bars have been replaced by bars made of a new alloy which has a working temperature up to 1325°C. The furnace construction is described and advantages are set forth. The furnace control is flexible. W.W.M.

Key to firing. ALBERTO PELLACINI. *Corriere ceram.*, **13** [2], 51–53 (1932).—Factors necessary for obtaining a successful firing are given, among the most important of which is the method of charging the kiln. M.V.K.

Firing vitrified ceramic products by shrinkage. P. BRÉMOND. *Céramique*, **35** [526], 7–10 (1932).—The firing shrinkages of a number of porcelain-type bodies from cones 05a to 14 are reported by graph and table. In all cases expansion occurred at the higher cones. The temperatures of maximum shrinkage did not necessarily correspond to the maturing temperatures. A.E.R.W.

Firing of stoneware products. ANON. *Tonind.-Ztg.*, **56** [17], 241–42 (1932).—Difficulties may arise in firing of stoneware products during the water-smoking process if the products are not dry enough when placed in the furnace. Several practical hints about the firing are given. W.M.C.

Smokeless fuel. ANON. *Refrac. Jour.*, **8** [2], 42 (1932).—The Salerni process consists of a rotating retort similar in principle to the rotating cement kiln. The experimental work on the process was carried out in the Dept. of Fuel Technology of Sheffield University. E.P.R.

Anthracite coal for firing clayware. ANON. *Brick Clay Rec.*, **80** [3], 144 (1932).—The advantages of anthracite coal in the clay products industry are briefly summarized. Performance data are given. E.J.V.

Using coal instead of natural gas for firing clayware. ANON. *Brick Clay Rec.*, **80** [3], 142–43 (1932).—Advantages of gas over coal are (1) low sulphur content, (2) cleanliness, (3) ease of control, (4) lack of ash and smoke, and (5) ease of transportation. The advantages of coal over gas are (1) adequate local supply, (2) lower investment in equipment, (3) lower cost, (4) lower kiln upkeep cost, and (5) use of semiskilled labor. E.J.V.

Grindability of coal. R. M. HARDGROVE. *Trans. A.S.M.E.*, **54** [1], 37–46 (1932).—H. points out the need for a method of determining the grindability of coal and outlines a method by which a prepared sample is partly pulverized and the new surface produced is measured in accordance with Rittinger's law. Two types of grindability machines, the mortar and pestle and the ball mill, are described, and test data between pulverizer capacity and grindability are discussed. A representative list of the coals of the U. S. and Canada is presented showing their grindabilities and the relation between grindability and volatile content. The relation between the grindability of petroleum coke and its method of manufacture and volatile content is discussed. E.P.R.

Pulverized fuel in the U. S. VERNON WALKER. *Elec. Rev.*, **110** [2835], 458 (1932).—Controversy still exists as to the relative merits of the direct-fired (unit) and the bin-storage systems. Boilers using the direct-fired system and having a capacity of 450,000 lb. per hr. generally use 2 mills per boiler with a load variation of 250,000 to 450,000 lb. and one mill from 150,000 to 250,000 lb. The unit system does not adapt itself to lighter loads as readily as the bin system. Tests on the Raymond mills show that the average fineness over two years has been such that 95% will pass through 100-mesh. Coal fineness is apparently not affected by mill output. Deterioration of plough points, rolls, and bull rings reduces mill output if the coal fineness is to be maintained constant.

Mill-drying has superseded steam driers with their high maintenance costs. Heated air or flue gas is introduced into the mills at a temperature of 350 to 400°F so that the temperature of coal and air on leaving the mills is approximately 100 to 130°F.

E.P.R.

Merits of pulverized fuel. S. B. JACKSON. *Elec. Rev.*, **110** [2833], 383 (1932).—The use of powdered coal, with special reference to power station practice, was the subject of a paper read at the Institute of Marine Engineers on March 8. Direct firing systems are being increasingly applied, principally because of their lower initial cost. Coal of high calorific value, small ash content, and uniform grading as delivered to the bunker is most suitable for efficient combustion. Powdered coal and stoker thermal efficiencies are compared and costs examined, the conclusion reached being that pulverized-fuel firing may eventually take the place of other systems in power stations.

E.P.R.

Pulverized fuel plant at Grimethorope colliery. ANON. *Engineering*, **131**, 39–42 (1931).—Illustrated. A.A.

The Third International Coal Conference in Pittsburgh, 1931. KURT BAUM. *Brennstoff-Chem.*, **13** [4], 68–71 (1932).—The papers presented at the conference are briefly summarized and discussed. J.L.G.

Gasification of low-grade fuel. M. BÖHM. *Giorn. chim. ind. applicata*, **14** [1], 21–23 (1932).—The method of using oxygen for the production of a good fuel gas from coal, lignite, or charcoal in an apparatus fed with oxygen and steam is discussed.

M.V.K.

Gas-fired furnaces. Notable automatic pyrometer control gear. ANON. *Chem. News*, **144** [3750], 138–39 (1932).—Operation of the apparatus is on the by-pass principle, with automatic control of only a part of the gas which is supplied to the burners by two pipes. Should the thermocouple fail, a bell immediately comes into operation.

G.R.S.

Influence of the requirements of operation in obtaining generator gas. GEORGE GEHLHOFF AND M. FULDA. *Glastech. Ber.*, **10** [3], 131–49 (1932).—The authors discuss the chemical processes taking place during the generation of gas and the influence exerted on it by the requirements of operation. The processes occurring in a gas generator depend on the temperature of the lowest zones in which the main conversions take place. The oxygen from the air blown in combines with carbon exclusively into CO_2 in the oxidation zone while the steam added remains undecomposed. The heat produced is used up in the next zone during the reduction of the steam and carbonic acid. The temperature of the reduction zone is decisive for obtaining the gasification. The lowering of the heat value of the gas during its transfer from the coal pile into the open space is due to the admixture of poor quality gas from the edges to the gas from the center. The advantage of having sufficient space which improves the quality of the gas and the decomposition of steam is explained. The increase of the charging power raises the heat value of gases through increased CO_2 reduction. The limit of the amount of steam to be added which can be completely decomposed in the gas generator is about 40 kg. per 100 kg. of gasified carbon for all fuels. A further increase of the quantity of steam up to about 77 kg. per 100 kg. of gasified carbon improves the quality of the gas when using older fuels. An index of literature on the subject is given. M.V.K.

Gasification of coal with oxygen at low temperatures. G. NATTA AND M. STRADA. *Giorn. chim. ind. applicata*, **14** [2], 76–86 (1932).—Through the gasification of coal poor in volatile material at low temperatures (700 to 800°) with oxygen and excess steam, it is possible to obtain directly gas rich in hydrogen and almost free from inert material, which, after the elimination of the carbonic anhydride, can be used in organic syntheses. The method and its industrial application are explained. M.V.K.

Heating air for combustion. ANON. *Power Plant Eng.*, **36** [7], 310–11 (1932).—As a means of recovering heat from flue gases the air heater in combination with an economizer has been found economical. E.P.R.

BOOKS

Electrochemistry. C. J. BROCKMAN. D. Van Nostrand Co., New York. 348 pp. Price $4.00. *Mining & Met.*, **13** [304], 204 (1932).—Applications of electrical current in chemical manufacture are pointed out. E.J.V.

1931 Report of Fuel Research Board. RICHARD THRELFALL AND C. H. LANDER. H. M. Stationery Office, London, 1932. Price 2s. Reviewed in *Times Eng. Supp.*, **29**, 392 (1932).—Brick retorts are now replacing cast iron in the low-temperature carbonization of coal. H.H.S.

Preparation, Selection, and Distribution of Coal. COAL TRADE LUNCHEON CLUB AND THE INST. OF FUEL. viii + 182 pp. Industrial Newspapers, Ltd., London, 1931. Reviewed in *Chem. & Ind.*, **51** [9], 192 (1932). G.R.S.

PATENTS

Electric furnace resistor element. FRANK A. FAHRENWALD. U. S. 1,849,288, March 15, 1932.

Purifying coal gas from hydrogen sulphide. GUSTAF HENRIK HULTMAN. U. S. 1,849,526, March 15, 1932.

Stack draft control apparatus. IRA T. MARTIN. U. S. 1,851,318, March 29, 1932.

Kiln car. PAUL A. MEEHAN, assignor to Swindell-Dressler Corp. U. S. 1,851,717, March 29, 1932.

Inductor type furnace. EDWIN FITCH NORTHRUP, assignor to Ajax Electrothermic Corp. U. S. 1,852,214, April 5, 1932.

Downdraft kiln. JAMES W. BALL. U. S. 1,853,596, April 12, 1932.

Tunnel-kiln roofs. F. M. HARTFORD AND S. M. KIER. Brit. 367,396, March 2, 1932.

Tunnel kilns with multiple-conveyer tracks. F. M. HARTFORD AND S. M. KIER. Brit. 367,397, March 2, 1932.

Retorts, furnaces, or kilns. R. NISBET. Brit. 368,427, March 16, 1932.

Firing ceramic ware. B. MOORE. Brit. 369,298, March 31, 1932.

Annular kiln. HEINRICH KREFTER. Ger. 530,546, July 4, 1930. (*C.A.*)

Means for measuring the temperature in tunnel kilns. HOLDING-GES. FÜR KERAMISCHE WERTE. Ger. 534,080, Aug. 26, 1930. The association of measuring means with the means for conveying the goods is described. (*C.A.*)

Gas-heated tunnel kiln for firing porcelain. HOLDING-GES. FÜR KERAMISCHE WERTE. Ger. 535,132, April 23, 1930. (*C.A.*)

Tunnel kiln for earthenware. HOLDING-GESELLSCHAFT FÜR KERAMISCHE WERTE. Ger. 536,800, April 24, 1929. Details of construction are given. (*C.A.*)

Geology

The nonmetallic-mineral resources of Mississippi. HUGH DONALD MOORE. *Pit & Quarry*, **24** [1], 41–44 (1932).—Commercial deposits of nonmetallic minerals found in Mississippi are asphalt sandstone and asphalt limestone, clays, cement material, road-making and concrete gravels, sand, silica, building stone, limestone, tripolite, marls, fuller's earth, acid-iron earth, bentonite, and bauxite. E.P.R.

Development of Idaho's nonmetallic-mineral resources. EDWARD L. TULLIS. *Pit & Quarry*, **23** [13], 22–27 (1932).—The nonmetallic-mineral resources of Idaho

discussed in their order of present importance are phosphate rock, clay, Portland-cement materials, limestone and marble, sandstone, mica, granite, basalt, rock salt, barite, diatomaceous earth, asbestos, and sulphur. E.P.R.

The barium industry. W. TRANTON. *Chem. & Ind.*, **51** [1], 5–8 (1932).—Practically all barium compounds are products from two raw materials, witherite and barite. The largest deposits of barite are in Germany. A discussion is given of the methods of mining, washing, and purifying this material. When heated to 900 to 1000°C the pure barite disintegrates into a fine powder. It is bleached by hot treatment with hydrochloric acid, after which it is washed, dried, and finely ground. An outline is given of the methods of preparation of various compounds of barium, emphasis being placed on precipitated barium carbonate. Some of its uses in the ceramic industries are pointed out. G.R.S.

Industry of baryta and barium compounds. ANON. *Ind. chimique*, **18** [209], 395–97 (1931).—A discussion of the use of baryta and of barium compounds is given. Barium carbonate is extensively used in ceramics to avoid efflorescence. It is a white insoluble salt and its pure chemical form is used in the manufacture of optical glass. Barium chloride is a white soluble salt and is also used in ceramics. M.V.K.

Winning of kaolin. I. H. N. BOSE. *Jour. Indian Ceram. Soc.*, **3** [2], 55–62 (1931).—B. reviews the various methods now employed in England, Germany, and Czechoslovakia. A.A.

Application of fluorspar. ANON. *Ind. chimique*, **18** [210], 521 (1931); *Ind. Silicati*, **10** [1], 15 (1932).—Because of its relatively low fusing point (1250 to 1400°), fluorspar constitutes a flux appreciated in metallurgy and is extensively used in ceramics. It lowers the vitrification point of Portland cement considerably and therefore great economies in fuel consumption are obtained. Its use is increasing in ceramics for manufacturing glazed stoneware, opalescent glasses, and enamels for metals. Recently, a kind of nonsiliceous porcelain with a pure fluorine base was produced which is used for chemical recipients. Fluorspar is also used in optics and ornamentation. M.V.K.

Kieselguhr industry. ANON. *Ind. chimique*, **18** [206], 219 (1931).—Kieselguhr is chiefly used as insulating material and for filtering; it is also mixed with cement. Numerous deposits of diatomaceous earth of excellent quality are found in Canada and data on its production are given. M.V.K.

Kieselguhr deposits in Austria. ANON. *Ind. chimique*, **18** [210], 523 (1931).—Large deposits of diatomaceous earth were found near Eggenburg. This material contains about 96% silica, is pure white, and has a low density. M.V.K.

BOOKS AND BULLETINS

Geologic Index of the Publications of the U. S. Geological Survey. G. H. ALBERTSON. Geological Pub. Co., Denver, Colo. 420 pp. Price $10.00. *Mining & Met.*, **13** [304], 204 (1932).—This index covers all the publications of the Survey and is classified by the latitude and longitude of each locality. Key maps make it easy to locate the desired entry where all the references to the locality will be found. E.J.V.

The Principles and Practice of Geophysical Prospecting. Report of the Imperial Geophysical Experimental Survey. A. B. BROUGHTON AND T. H. LABY. Cambridge University Press, London. Price 15s net. Reviewed in *Engineering*, **133** [3448], 195–96 (1932). A.A.

China Clay. ANON. *Ceram. Ind.*, **18** [4], 234 (1932); for abstract see *Ceram. Abs.*, **11** [5], 235 (1932). W.W.M.

Simple Determinative Mineralogy. H. R. BERINGER. 227 pp. Price 10s 6d. *Mining & Met.*, **13** [304], 203 (1932); for abstract see *Ceram. Abs.*, **11** [4], 264 (1932). E.J.V.

Sampling and exploration by means of hammer drills. JOHN B. KNAEBEL. Bur. Mines, *Information Circ.*, No. 6594, 29 pp. (Free.) The application of hammer machines for underground sampling and exploration may be divided into two classes: (1) sampling and testing with ordinary drilling equipment to a depth of 22 ft. or less, and (2) "long hole" drilling with heavy machines and special equipment to depths of as much as 250 ft. or more. K. summarizes his experiences and discusses the applicability of the method comparing the technical results and costs with other methods and costs. The drilling equipment is described. R.A.H.

Bibliography of North American Geology, 1929–30. J. M. NICKLES. Geol. Surv., *Bull.*, No. 834, 280 pp. *Bull.* Nos. 746, 747, 823, and 834 cover the field of North American geology from 1785 to 1930. Price 45¢ from Supt. of Documents, Govt. Printing Office, Washington, D. C. See also *Ceram. Abs.*, **10** [8], 598 (1931). R.A.H.

Geophysical Abstracts. XXXIV. FREDERICK W. LEE. Bur. Mines, *Information Circ.*, No. 6569, 27 pp. (Free.) This report continues the monthly review of recent papers, books, and patents concerning methods and instruments for geophysical abstracting. For XXXIII see *Ceram. Abs.*, **11** [5], 325 (1932). R.A.H.

Barite and barium products in 1930. R. M. SANTMYERS AND B. H. STODDARD. Bur. Mines, *Mineral Resources U. S.* 11 pp. 5¢. R.A.H.

Clays and shales of Prince Edward Island. HOWELLS FRÉCHETTE AND J. F. MCMAHON. Can. Dept. Mines, Mines Branch, *Rept.*, No. 722, pp. 24–27 (1931).—Some of the shales of Prince Edward Island are suitable for heavy clay products and even pottery. The clays are less promising. (*C.A.*)

Chemistry and Physics

Kaolins: effect of firing temperature on some of their physical properties. R. A. HEINDL, W. L. PENDERGAST, AND L. E. MONG. Bur. Stand., *Jour. Research*, **8** [2], 199–215 (1932).—Samples of 5 kaolins, representing some of the important world sources, were fired at 8 temperatures ranging from 1100 to approximately 1650°C. The chemical analyses and pyrometric cone equivalents were obtained on the raw materials, the thermal expansion, porosity, and specific gravity on the fired materials, and the petrographic analyses on both the raw and fired. X-ray diffraction patterns were made of Ga., N. C., and Mexican (dickite) kaolins, mullite, and cristobalite. The following results were reported: (1) The chemical and petrographic analyses show the Ga. and Zettlitz kaolins to be of greater purity than the N. C. and Del. kaolins or the English china clay. (2) The specific gravity of the Ga. and Zettlitz kaolins is, in general, higher than that of the other three. (3) The porosity of the N. C. kaolin is the highest and shows the least change over the range of temperature used. (4) After firing the purer Ga. and Zettlitz kaolin at the same temperatures, the linear thermal expansion between approximately 100 and 200°C is decidedly greater than that of the other three. (5) Progressively increasing the firing temperature of the kaolins affects the thermal expansion of those containing the greater amount of foreign material to a less extent than it does those of higher purity. The former are also affected less by changes in the rate of cooling. (6) Addition of 15% muscovite to the Ga. kaolin measurably affected its P.C.E., but after firing at 1400°C the thermal expansion of the mixture was greatly reduced when compared with that obtained on the kaolin alone after firing at the same temperature. Addition of alumina in amounts based on the quantity of free silica present increased the mullite almost to 100% when certain of the materials were fired at the highest temperature. (7) Evidence is given which indicates that the high rate of expansion shown by certain fired refractory clays is primarily caused by the

presence of cristobalite. This cristobalite may form as a result of (*a*) free quartz in the unfired material or (*b*) excess silica from the reaction involving the formation of mullite from clay. (8) X-ray diffraction patterns show the presence of cristobalite in one of the fired clays. The high rate of expansion caused by the α to β form begins approximately 75° below the usually accepted lower limit of the temperature range of this inversion. (9) The high rate of expansion between approximately 100 and 210°C, due to the presence of cristobalite in some of the fired kaolins, is similar to the expansion of cristobalite prepared from precipitated amorphous silica which also occurs approximately between 100 and 210°C. R.A.H.

Phase equilibria in the system SiO_2–ZnO–Al_2O_3. E. N. BUNTING. Bur. Stand., *Jour. Research*, **8** [2], 279–87 (1932).—A study of the phase equilibria in the system SiO_2–ZnO–Al_2O_3 shows that no ternary compounds are formed. Two ternary eutectics are present: one at 52 mol % SiO_2, 40% ZnO, 8% Al_2O_3, and 1305 ± 5°C, with tridymite, Zn_2SiO_4, and ZnO·Al_2O_3 as the solid phases; the other 18.5 mol % SiO_2, 71.3% ZnO, 10.3% Al_2O_3, and 1440 ± 5°C, with ZnO, Zn_2SiO_4, and ZnO = Al_2O_3 as the solid phases. There are also 2 quintuple points which are not eutectics; one at 63 mol % SiO_2, 26% ZnO, 11% Al_2O_3, and 1400 ± 5°C, with tridymite, ZnO·Al_2O_3, and mullite as the solid phases; the other in the neighborhood of 40% SiO_2, 23% ZnO, 37% Al_2O_3 at about 1750°C with Al_2O_3, ZnO, Al_2O_3, and mullite as solid phases. From the standpoint of resistance to slag formation an alumina retort containing as little silica as possible should give much better service than the ordinary clay retort as the container for the charge in the zinc retort furnace. R.A.H.

System CaO–Na_2O–Al_2O_3. L. T. BROWNMILLER AND R. H. BOGUE. Bur. Stand., *Jour. Research*, **8** [2], 289–307 (1932).—The studies reported in this paper are in continuation of a series begun several years ago to determine the constitution of Portland cement clinker and the part played by each of the compounds in the manufacture and utilization of that product. A part of the system CaO–Na_2O–Al_2O_3, in the region low in Na_2O, has been investigated by the methods of phase equilibria. The stability fields, boundary curves, and invariant points have been defined. Optical and X-ray data are presented and ternary diagrams introduced to indicate the composition and temperature relations and the course of crystallization in the system. R.A.H.

Heat of vaporization of water at 50, 70, and 90°C. E. F. FIOCK AND D. C. GINNINGS. Bur. Stand., *Jour. Research*, **8** [3], 321–24 (1932); R.P. 416.—The values of the heat of vaporization of water at 50, 70, and 90°C have been determined as 2381.6, 2333.6, and 2283.4 international joules per gram. R.A.H.

Note on international comparison of X-ray standards. L. S. TAYLOR. Bur. Stand., *Jour. Research*, **8** [3], 325 (1932).—T. makes a correction to the paper published on this subject in Research Paper 397, Jan., 1932 (for abstract see *Ceram. Abs.*, **11** [4], 269 (1932)). R.A.H.

Arc spectrum of phosphorus. C. C. KIESS. Bur. Stand., *Jour. Research*, **8** [3], 393–95 (1932); R.P. 425.—A new infra-red sensitizer permits the hitherto unknown portion of this spectrum to be photographed. R.A.H.

"Single value" soil properties: significance of certain soil constants. I. B. A. KEEN AND J. H. R. COUTTS. *Jour. Agric. Sci.*, **18** [4], 740–65 (1928).—The investigation covered 39 soils, ranging from heavy clays to light sands. The percentage of clay was determined in the usual way (settling velocity 8.6 cm. in 24 hr. at 15°C). The air-dry moisture content was determined by heating 24 hr. in a steam oven. The moisture content at 50% relative humidity was determined in a vacuum over sulphuric acid. The sticky point (*i.e.*, the point where the plastic mass no longer sticks to the hands or knife) was determined by feel. The volume shrinkage was determined by the Haines method and from this determination the pore space and apparent and true specific

gravities of the oven-dried block were found. Ignition losses were determined on the dried soils as was the calcium carbonate content. Total carbon was determined in some cases. It was found that the pore space of kneaded blocks was reduced 4 to 5% by treating the soil with hydrogen peroxide previous to forming. Treatment with peroxide removed about 75% of the total organic matter of the soil. Heavy clay soils had the highest ignition losses, moisture contents, and sticky points. The peroxide treatment increased the correlation between clay content and sticky point. The sticky point was shown to be largely controlled by the colloidal organic and inorganic matter. The moisture at 50% relative humidity was controlled by the actual clay content. Independent evidence indicated this moisture to be interstitial. The sticky point approached a lower limit of about 16% moisture with very sandy soils containing little organic matter. Four diagrams are included. **II. Natal soils.** J. R. H. Coutts. *Ibid.*, **19** [2], 325–41 (1929).—Sixty-six Natal soils were examined. The following determinations were made: (1) mechanical analysis (to obtain the clay content), (2) moisture content of air-dry soil, (3) moisture content in equilibrium with an atmosphere of 50% relative humidity, (4) loss on ignition, (5) moisture content at the sticky point, and (6) Keen-Raczkowski perforated box determination which gives (*a*) moisture content of saturated soil, (*b*) pore space, and (*c*) swelling. In addition, the Haines shrinkage experiment performed on half the soils gave data for calculating (1) pore space, (2) apparent specific gravity, and (3) total shrinkage. The sticky point and the loss on ignition are shown to be closely correlated with one another as are the clay content and the water content in equilibrium with an atmosphere of 50% relative humidity. The sticky point and the loss on ignition give the better estimate of the colloid status of the soil. The water content in equilibrium with an atmosphere of 50% relative humidity differs but slightly from the air-dry moisture of the soil. The mechanical analyses of the soils fall into groups which correspond with their geologic origin. The perforated box experiments show that the pore space is closely related to the clay content of the soil and that volume swelling is closely related to the water retained and, therefore, to the sticky point. The volume swelling and the water retained indicate the colloidal status of the soil. **III. Technique of the Keen-Raczkowski box experiment.** *Ibid.*, **20** [3], 407–13 (1930).—A modified form of the original Keen-Raczkowski perforated box for measuring soil constants is described. The modified form consists of a piece of brass tubing 2 in. inside diameter and $^5/_8$ in. long, closed at one end with a perforated bottom. The filter paper used between the soil in the box and the water below is held against the perforated bottom by a split brass ring. Results obtained for pore space are nearly the same as those given with the old rectangular apparatus. The old and new results for water retention and swelling are related to one another by simple linear expressions. Three diagrams are included. **IV. A further note on the technique of the "box" experiment.** B. A. Keen. *Ibid.*, **20** [3], 414–16 (1930).—Precipitated silica was used in filling the Keen-Raczkowski box in place of soil and different degrees of packing were obtained by the impact of a falling weight. The results indicated that the swelling was a function of the degree of packing. Packing by tapping the box on a bench seemed always to give the same apparent specific volume and hence the same results. From the fact that such an inert material as precipitated silica showed a swelling when saturated with water, K. raises the question as to what degree imbibitional water is concerned in the volume expansion of a soil. One diagram is included. **V. Changes produced in a soil by oven drying.** J. R. H. Coutts. *Ibid.*, **20** [4], 541–48 (1930).—The determinations were made in an electrically controlled Hearson oven. On heating soils to temperatures ranging from 50 to 250°, results were obtained which gave smooth curves for loss in weight plotted against increase in temperature. The conclusion is drawn that there is no sudden alteration in the structure of a soil when it is

heated to 100° and that the air-dry moisture of a soil is a convenient empirical factor but not a representation of any fundamental soil property. An explanation is offered of the contributions made by the different types of soil water and by the soil colloids to the total loss in weight. The absence of any sharp dividing line between the different classes into which the soil water is usually divided is stressed. One diagram is included. J.L.G.

Molecular and atomic volumes. No. 35. Volumetric density determinations on small amounts of substances. ADOLF SAPPER. *Z. anorg. allgem. Chem.*, **203** [3], 307–11 (1932).—A volumetric method for accurate density determinations of amounts of materials up to 1.5 cm.³ is described. Former methods required about 10 cm.³ **No. 38. Volumes of some silicates.** WILHELM BILTZ AND ALFRED LEMKE. *Z. anorg. allgem. Chem.*, **203** [3], 330–34 (1932).—Density determinations by means of a pycnometer were made on a series of silicates. The authors found that the molecular volumes of the Al_2O_3-free silicates are additive from the molecular volumes of their respective constituent oxides to within 5% error. Silicates which may occur in two or more modifications have molecular volumes lying between the extreme values of such calculations. This is evidence that the state of the atoms in the single oxides can not be far different from that in the silicates. Comprehensive data, including molecular volumes, densities, and crystallographic forms, are given. The final section of the paper deals with the silicates which contain Al_2O_3, of which the molecular volumes are not additive. These cases are discussed from the standpoint of atomic structural ideas as expounded by Bragg and Goldschmidt. **No. 39. Calculations of the volumes of technical glasses.** WILHELM BILTZ AND FRIEDRICH WEIBKE. *Z. anorg. allgem. Chem.*, **203** [3], 345–64 (1932); for abstract see *Ceram. Abs.*, **11** [2], 89 (1932). L.T.B.

Separation of tin from tantalum and niobium. W. R. SCHOELLER AND H. W. WEBB. *Analyst*, **56**, 795–801 (1931).—In order to separate small amounts of Sn from much earth acid, fuse with bisulphate, take up with tartaric acid, and treat with H_2S. To separate small amounts of earth acid from much Sn, reduce tin oxide with hydrogen. H.H.S.

Field map of ceramics. JOSEPH WOLF. *Sprechsaal*, **65** [10], 175–77 (1932).—W. discusses the attempts of A. Laubenheimer (*Ceram. Abs.*, **8** [12], 916 (1929)) to classify the important quartz-kaolinite-feldspar rocks into definite groups with the help of the 3-component system and the works of A. Pfaff and M. Donath (*Ber. deut. keram. Ges.*, **1** [2], 31–32 (1920)). In a previous work (*Ceram. Abs.*, **10** [3], 222 (1931)), W. represented the group alumina-quartz-feldspar in an equilateral triangle. In the same way he represents the fields of alumina, mullite, and sillimanite masses, refractory materials, quartz clay, clay Dinas, hard clay, flint clay, kaolin slip, quartzite, and moler earth. M.V.K.

Reaction between calcium carbonate and silica. W. MASKILL, G. H. WHITING, AND W. E. S. TURNER. *Pottery Gaz.*, **57** [658], 505 (1932).—This reaction was studied (1) through determinations of the rate of decomposition with mixtures of calcium carbonate (calcite ground to less than 0.063 mm. diameter) and silica (ground quartz rock, 0.098 to 0.075 mm. diameter), the two being mixed in different molecular proportions and heated isothermally at 700, 750, and 800°C, and (2) by chemical analysis of the products of these and other heating experiments. The maximum effect of silica in the mixtures with three molecular proportions was roughly to halve the time of decomposition with calcium carbonate alone. E.J.V.

Dry quenching applied to the cement and lime industries. A. B. WOLLE. *Rock Prod.*, **35** [6], 66–68 (1932).—W. shows the heat content of lime and cement clinker at various temperatures and gives examples of the savings from heat recuperation. Illustrated. W.W.M.

X-ray crystal analysis in industrial problems. ANON. *Engineering*, **133** [3443], 29–30 (1932).—X-rays reveal the internal structure of solid bodies and open the way to the expression of their properties in terms of structure. See also *Ceram. Abs.*, **10** [12], 864 (1931). A.A.

Relative and absolute humidities. A. F. DUFTON. *Chem. & Ind.*, **51** [11], 94 (1932).—To convert relative humidity readings into absolute humidity, a simple alignment diagram is shown by which a standard conversion equation may be solved. G.R.S.

Rhodium dioxide. LOTHAR WOHLER AND K. F. A. EWALD. *Z. anorg. allgem. Chem.*, **201** [2], 145–61 (1931).—Methods for making rhodium dioxide are given. The authors were unable to make the anhydrous salt. L.T.B.

Quantitative determination of phosphoric and phosphorous acids. LUDWIG WOLF AND WALTER JUNG. *Z. anorg. allgem. Chem.*, **201** [3], 337–45 (1931).—The determination of these acids in the presence of each other was done by oxidation with iodine in alkaline bicarbonate medium. The method is described and results of determinations are included. L.T.B.

Formation of Ba-silicates from $BaCO_3$ and SiO_2 in the solid state. G. GRUBE AND R. TRUCKSESS. *Z. anorg. allgem. Chem.*, **203** [1], 75–96 (1931).—Experiments were made to find what compounds of BaO and SiO_2 exist and to measure the CO_2 pressure during the reaction between the raw materials. Analytical work shows that $2BaO \cdot SiO_2$ and another silicate higher in BaO are formed as well as $BaO \cdot SiO_2$. The CO_2 pressure during the formation of these compounds is measured and recorded. There is also a solid solution of $2BaO \cdot SiO_2$ and $3BaO \cdot SiO_2$. It could not be definitely established whether the reaction, $3BaO \cdot SiO_2 + BaCO_3 = 4BaO \cdot SiO_2 + CO_2$, takes place in the solid state. There is some evidence, however, that the tetra compound exists. L.T.B.

Determination of sulphur present as sulphide in Portland cement. D. I. WATSON. *Cement & Cement Mfg.*, **5** [2], 49 (1932).—The usual evolution methods for determining sulphides are not suitable for Portland cement because the cement contains soluble iron compounds which dissolve in the ferric state and immediately react to oxidize part of the sulphide to sulphate. A method is described in which the ferric iron is reduced by stannous chloride to prevent the conversion of the sulphide to sulphate and thus to attain accurate results by the evolution method. W.L.

Gases obtained from commercial feldspars heated *in vacuo*. G. R. SHELTON AND H. H. HOLSCHER. Bur. Stand., *Jour. Research*, **8** [3], 347–56 (1932).—Nineteen samples of ground feldspars were heated *in vacuo* in steps of 100°, from 400 to 1000°C. Carbon monoxide and hydrogen were determined in some of the samples. Two feldspars were heated from 400 to 1200°C in steps of 100°. Water vapor was given off above the drying temperatures, the maximum being obtained between 800 and 900°C. Acid gases started at about 500°C, and increased rapidly between 600 and 900°C. No hydrogen and only small quantities of carbon monoxide were found. At 1000°C the gases were found to consist by weight of 32 to 96% water vapor, 0 to 59% acid gases, and 0 to 36% unabsorbed gases. Volume calculations indicated that 1 ml. of feldspar would yield 16 to 40 ml. of water vapor and 0 to 15 ml. of acid gases (calculated as CO_2 measured at 1000°C). R.A.H.

Chromium oxide and vanadium oxide band spectra. W. F. C. FERGUSON. Bur. Stand., *Jour. Research*, **8** [3], 381–84 (1932); R.P. 423.—More complete and precise vibrational analyses were made of the spectra of chromium oxide and vanadium oxide. R.A.H.

Iodimetric determination of ferric iron. E. RUPP. *Z. anal. Chem.*, **86**, 217–19 (1931); *Analyst*, **57**, 59–60 (1932).—The method is based upon conversion of Fe into ferricyanide and its reaction with iodide: $K_3 Fe Cy_6 + KI = K_4 Fe Cy_6 + I$. H.H.S.

Analysis of cadmium red pigments. C. G. DAUBNEY. *Analyst*, **57**, 22–25 (1932).—Se is precipitated by hydrazine hydrochloride, and Cd as an 8-hydroxyquinoline complex. H.H.S.

Antipyrine as reagent for cobalt. K. WOYNOFF. *Chem.-Ztg.*, **55**, 914 (1931); *Analyst*, **57**, 60 (1932).—Antipyrine in solutions gives no color change with Co but if the mixed solution is allowed to dry on a filter paper, a characteristic blue color is produced. H.H.S.

New colorimetric method for determination of potassium. H. R. D. JACOBS AND W. S. HOFFMAN. *Jour. Biol. Chem.*, **93**, 685–91 (1931); *Analyst*, **57**, 60 (1932).—The formation of a stable colored compound of cobalt (prepared from cobalt choline and ferrocyanide) and its application to the microdetermination of K is described. H.H.S.

Quantitative spectrographic analysis. A. SCHLEICHER AND J. CLERMONT. *Z. anal. Chem.*, **86**, 191–216, 271–88 (1931); *Analyst*, **57**, 66 (1932).—Preference is given to Gerlach and Schweitzer's "absolute method" (see *Ceram. Abs.*, **10** [6], 459 (1931)) over the "ultimate rays" method of Hartley and de Gramont. H.H.S.

Phosphoric acid for separating in analysis of raw materials, fired bodies, and mortars. H. HIRSCH AND W. DAWIHL. *Tonind.-Ztg.*, **56** [22], 306–308 (1932).—The use of phosphoric acid was studied extensively. It may be used advantageously for rational analysis in the ceramic industry and in the analysis of mortars. The method is described. W.M.C.

Sulphurous kiln gases. ANON. *Brit. Clayworker*, **40** [479], 426 (1932).—This is a popular discussion of results obtained by Hans Hirsch. R.A.H.

Determination of silica and alumina in refractory materials. C. PERTUSI AND E. DI NOLA. *Ann. chim. applicata*, **21**, 482–90 (1931).—Twenty to twenty-five cubic centimeters of HF are added to 1 g. of finely powdered material in a tared Pt crucible and evaporated to dryness on the water bath. After repeating twice, the residue is treated with 15 to 20 cc. of concentrated $H_2C_2O_4$ solution, evaporated to dryness, and ignited. The total oxides are thus obtained and the difference gives the SiO_2. The total oxides are fused for a few minutes in a Ni crucible containing 5 g. NaOH. After cooling, the melt is exhausted with boiling H_2O and the liquid collected, boiled, and filtered. In the filtrate $Al(OH)_3$ is precipitated with NH_4Cl and aqueous NH_3 and Al_2O_3 is determined in the usual way. When Ti is present in small amounts it is left in the residue together with $Fe(OH)_3$. Alternatively, the total oxides are fused with $KHSO_4$, the melt is dissolved in dilute H_2SO_4 and made up to 300 cc., and in an aliquot part of the solution Fe is determined with $KMnO_4$ and Ti colorimetrically by Weller's method. Al_2O_3 is determined by difference. (*B.C.A.*)

Special applications in methods of agricultural chemical analysis. C. A. BROWNE. *Jour. Assn. Official Agric. Chem.*, **15** [1], 112–18 (1932).—A number of special methods and trends in agricultural chemical analysis are discussed. J.L.G.

Determination of calcium by picrolonic acid. R. DWORZAK AND W. REICH-ROHRWIG. *Analyst*, **56**, 832–33 (1931); for abstract see *Ceram. Abs.*, **11** [4], 274 (1932). H.H.S.

BOOKS

Nature of a Gas. L. B. LOEB. John Wiley & Sons, New York. 153 pp., diagrams, charts, tables. Price $2.50. *Mining & Met.*, **13** [304], 204 (1932).—This review of the nature and electric properties of a gas is of value to those interested in the behavior of dielectrics as insulation. The structure of the molecule is discussed and the behavior of molecules under various temperatures is considered. Attention is also given to the phenomena of ionization. E.J.V.

Progress of X-ray Research in Methods and Application. (Fortschritte der Röntt-

genforschung in Methode und Anwendung.) F. KOCKE AND E. SCHIEBOLD. Akademische Verlagsgesellschaft, Leipzig, 1931. Price 32 M. *Z. Ver. deut. Ing.*, **75** [49], 1493 (1931); *Z. physik. Chem.*, **157***A* [5], 470 (1931).—The main part of the book treats of fundamental physical principles, while direct technical aspects are few. The sections deal with X-ray research on liquids and gases, interference and diffraction phenomena of crystals, and X-ray spectroscopy. L.T.B.

Recent Advances in Physical Chemistry. S. GLASSTONE. 470 pp. J. & A. Churchill, London, 1931. Price 15s. Reviewed in *Analyst*, **57**, 68–69 (1932). H.H.S.

X-Ray Technique in Materials Testing. J. EGGERT AND E. SCHIEBOLD. *Z. Metallkunde*, **23** [10], 290 (1931); see *Ceram. Abs.*, **10** [5], 392 (1931). L.T.B.

Physical-Chemical Tables. (Physikalisch-chemische Tabellen. Bd. 2, Tl. 2.) HANS LANDOLT AND RICHARD BÖRNSTEIN. 5th ed., revised and enlarged. Edited by Walther Adolf Roth and Karl Scheel. Published by J. Springer, Berlin. 1200 pp. Bound, 169 M. For Vol. I see *Ceram. Abs.*, **8** [1], 75 (1929). (*C.A.*)

Recent Advances in Analytical Chemistry: Vol. II. Inorganic. C. A. MITCHELL. xiv + 452 pp. J. & A. Churchill, London, 1931. Price 15s. Reviewed in *Analyst*, **56**, 839–40 (1931). H.H.S.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. XI. Te, Cr, Mo, W. J. W. MELLOR. Reviewed in *Analyst*, **56**, 838–39 (1931); for abstract see *Ceram. Abs.*, **10** [10], 735 (1931). H.H.S.

PATENTS

Preparing highly concentrated titanium sulphate solutions. FRIEDRICH RASPE AND PAUL WEISE, assignors to I. G. Farbenindustrie Akt.-Ges. U. S. 1,849,153, March 15, 1932.

Production of anhydrous aluminum chloride. CYRIL B. CLARK, assignor to General Chemical Co. U. S. 1,851,272 and 1,851,273, March 29, 1932.

Manufacture of aluminium fluoride. MAX ZIMMERMANN, assignor to I. G. Farbenindustrie Akt.-Ges. U. S. 1,851,475, March 29, 1932.

Preparation of titanium hydroxide. JOSEPH BLUMENFELD, assignor to Krebs Pigment and Color Corp. U. S. 1,851,487, March 29, 1932.

Treating titaniferous materials with acid. PEDER FARUP, assignor to Titan Co. A/S. U. S. 1,852,510, April 5, 1932. The process of rendering titaniferous materials soluble which comprises treating the materials with an acid in the presence of an iron sulphide having been previously subjected to heating and rapid cooling.

Manufacturing titanic oxide suitable for use as pigment. KARL LEUCHS. U. S. 1,853,626, April 12, 1932. The process of manufacturing titanic oxide from titanic ores which consists in rendering titanium ore soluble by means of sulphuric acid, dissolving the product in water, precipitating titanium hydroxide by means of magnesium oxide, separating the precipitate, dissolving the precipitate in sulphuric acid, and heating the solution.

Treatment of leucite and other alkali aluminum silicates with nitric acid. G. A. BLANC. Brit. 367,524, March 2, 1932.

Production of aluminum oxide from aluminum nitrate in which the decomposition of nitric acid is reduced to a minimum. G. A. BLANC. Brit. 367,525, March 2, 1932.

Production of trisodium phosphate. CHEMISCHE FABRIK BUDENHEIM AKT.-GES. Brit. 369,146, March 23, 1932.

Recovery of beryllium compounds from beryllium-bearing minerals. C. ADAMOLI. Brit. 369,162, March 23, 1932.

Titanium dioxide. VEREIN FÜR CHEMISCHE UND METALLURGISCHE PRODUKTION. Ger. 533,836, March 16, 1928. Finely divided TiO_2 is obtained from Ti tetrahalides by

treatment with steam and solid soluble salts. The Ti tetrahalide is ground with alkali chloride or sulphate and the mass heated to 400°. The temperature is raised to 800° and a current of steam passed over the mass. The TiO_2 is then separated from the salt by a solvent. (*C.A.*)

Alkaline earth aluminates. LONZA-WERKE ELEKTROCHEM. FAB. G.M.B.H. Ger. 535,067, Dec. 7, 1930. Aluminous material such as bauxite is introduced into a reducing melt comprising CaC_2, with or without $Ca(OH)_2$. Ca aluminate and an alloy of the impurities in the bauxite, *e.g.*, an Fe–Si–Ti alloy, are obtained. The aluminate and the alloy are tapped separately from the furnace. Other alkaline earth aluminates may be prepared similarly. (*C.A.*)

General

Presidential address for the Thirty-Fourth Annual Meeting of the AMERICAN CERAMIC SOCIETY. ECKARDT V. ESKESEN. *Bull. Amer. Ceram. Soc.*, **11** [4], 77–81 (1932).

Condolence from organizations abroad on the passing of General Orton. ANON. *Bull. Amer. Ceram. Soc.*, **11** [5], 138 (1932).

Repair shop procedure. JOHN B. TUFTS. *Maintenance Eng.*, **90** [4], 145–48 (1932).—The record system used by the Electric Motor Repair Co., Springfield, Mass., is described. Illustrated. J.L.G.

Color increases shop efficiency. T. J. MALONEY. *Factory & Ind. Management*, **83** [4], 139–42 (1932).—M. discusses the use of pastel colored factory equipment for various operations. E.C.C.

Advertising domestic dinnerware. ANON. *Ceram. Ind.*, **18** [4], 228–29 (1932).—Foreign competition may be fought by making housewives style conscious and putting a trade-in value on old sets. W.W.M.

Colors of chromium. H. WEITZE. *Abrasive Ind.*, **13** [4], 20 (1932).—The metal chromium is steel white in color, capable of taking on a brilliant polish that reflects light in an unusual manner. Potassium chromium alum is a dark violet substance, chromic oxide is green, chromic hydroxide is blue, chromous hydroxide is yellow, and potassium dichromate is red. Lead chromate is a brilliant yellow and is an important yellow pigment known to painters as chrome yellow. The principal supply of chromium now being worked is in Rhodesia, Africa. E.P.R.

Motion picture as an aid to refractories research. THOMAS S. CURTIS. *Bull. Amer. Ceram. Soc.*, **11** [5], 114–23 (1932).

Materials testing. ERNST LEHR. *Z. Ver. deut. Ing.*, **75** [46], 1401–1409 (1931).—A general discussion of the recent developments in materials testing as applied to rocks, cement, and concrete is given. A section is devoted to particle size and size distribution. L.T.B.

Powdered coal in the coal-dust engine. TETSURO SUWA. *Power Plant Eng.*, **36** [7], 303–304 (1932); for abstract see *Ceram. Abs.*, **11** [4], 263 (1932). E.P.R.

Value of clean coal for steam generation. EDWIN B. RICKETTS. *Power Plant Eng.*, **36** [7], 291–92 (1932).—The effect of variations in the ash content of coal on its value for steam generation is discussed. Formulas for calculating the effect of ash content on steam costs are given. E.P.R.

Pulverization and boiler performance. E. H. TENNEY. *Trans. A.S.M.E.*, **54** [1], 55–65 (1932); for abstract see *Ceram. Abs.*, **11** [2], 128 (1932). E.P.R.

Effect of grate temperature on combustion. JOHN BRUCE. *Mech. World*, **91** [2360], 291–92 (1932).—Experiments with high air temperatures on a traveling-grate stoker installation showed an uncontrollable increase in furnace temperature. At the same

time an irregular form of combustion occurred accompanied by a "cauliflower" phenomenon in the fire bed. It is deduced that with the usual run of bituminous slack coal, air temperature is limited to about 350°F. E.P.R.

Conversion of coal-fired boilers and furnaces to gas firing. W. D. EDWARDS. *Trans. A.S.M.E.*, **54** [1], 23–28 (1932).—E. deals with the use of natural gas in the city of Memphis, the methods and data used in making estimates of gas consumption, the application of the degree day, and the actual operating data for various types of plants converted to gas fuel. E.P.R.

Economizing in the boiler house. ANON. *Brit. Clayworker*, **40** [479], 422–23 (1932). R.A.H.

Control of coal pile. FRED J. POSTEL. *Factory & Ind. Management*, **83** [3], 126–28 (1932).—Methods of eliminating boiler plant losses are discussed. E.C.C.

Using statistics in the conduct of business. R. S. TILDEN. *Brick Clay Rec.*, **80** [3], 157–61 (1932).—T. shows how the record of inventories and shipments in the Hudson River district has held the prices of brick firm and has controlled production. E.J.V.

American practice in the ceramic industry. H. ENGEL. *Tonind.-Ztg.*, **56** [22], 308–309; [24], 336–38 (1932).—E. reviews some mechanical devices used in the American ceramic industry. Similar arrangements are emphasized for European use. W.M.C.

Scientific property. J. HETTINGER. *Sci. Prog.*, **26**, 449–61 (1932).—The patent system and the protection of ideas which are not patented are discussed nationally and internationally. H.H.S.

Prepare for critical markets. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **11** [5], 107 (1932).

Turn slip checks losses in production. WILLIAM A. FAWCETT. *Glass Ind.*, **13** [4], 73 (1932).—The Macbeth-Evans Glass Co. of Charleroi, Pa., uses a turn slip to follow production. Illustrated. E.J.V.

All clay products house. ANON. *Brick Clay Rec.*, **80** [3], 162–63 (1932).—The Milwaukee Home Show is featuring a model home which is made entirely of clay products. Illustrated. E.J.V.

Lessons from the American Concrete Institute for the Clay Products Institute. H. WHIPPLE. *Jour. Clay Prod. Inst.*, **1** [1], 9–12 (1931). G.R.S.

Pottery and glassware exhibits at the British Industries Fair. ANON. *Pottery Gaz.*, **57** [658], 485–500 (1932).—Brief descriptions of the exhibits in this section at Olympia are given. Illustrated. E.J.V.

Ceramics at the Leipzig fair of 1932. ANON. *Sprechsaal*, **65** [7], 130 (1932); *Glashütte*, **62** [11], 182–83 (1932).—Different new glass, porcelain, enamelware, refractory glassware, crucibles, kilns, etc., are described. M.V.K.

Technical excursion of the "Syndicat" in Burgundy. ANON. *Céramique*, **34** [525], 302–18 (1931).—An account is given of a four-day technical excursion organized by the French Society of Ceramic Manufacturers. Ten factories were visited which manufactured tile, ceramic machinery, kilns, steel, refractories, sanitary ware, stoneware, and pottery. A.E.R.W.

Three-day convention for brickmakers in Berlin. ANON. *Tonind.-Ztg.*, **56** [17], 236–39; [19], 263–65 (1932).—During the "three days for brickmakers" organized by the Tonindustrielaboratorium, Berlin, Germany, several papers were read and discussed. Schubert dealt with the advertising of brick and brick buildings; Streck, with the management of brick plants during times of depression; Thomas, with the care of machinery; and Hartmann, with his type of open-air drying plants. Further papers were read which included testing of the raw materials and products (Pulfrich) and economic problems. W.M.C.

Convention of brickmakers. ANON. *Tonind.-Ztg.*, **56** [21], 291–93; [23], 324–26 (1932).—The following subjects were discussed: (1) the use of brick for building purposes, by Thein and Lee, (2) special products to be made in brick plants, by Winkler, (3) hard-fired brick for road construction, by Dieskau, and (4) manufacture and use of terra cotta, by Henze. W.M.C.

BOOKS

Explosive Shattering of Minerals as a Substitute for Crushing Preparatory to Ore Dressing. R. S. DEAN AND JOHN GROSS. Bur. Mines, *Rept. of Invest.*, No. 3118, 5 pp. (Free.) Explosive crushing depends upon an expansible substance within the pores of a solid body. The expansion may be obtained by the detonation of an explosive or by the sudden release of pressure of a super-heated liquid. Cracks, cleavage planes, and pores exist in all minerals. The report discusses the nature of expansible substances, effects of pressure, amounts of water, time of soaking, and explosive experiments in ores. R.A.H.

Strength of Materials. Part I. Elementary Theory and Problems. Part II. Advanced Theory and Problems. S. TIMOSHENKO. Macmillan and Co., London. Part I 15s net, Part II 18s net. Reviewed in *Engineering*, **133** [3442], 19 (1932). A.A.

Research Laboratory Record (*New journal*). Published monthly by the Nelson Publishing Co., Inc., 420 Lexington Ave., New York City. Vol. I, No. 1 appeared in November, 1931. $5 per year. (*C.A.*)

Industrial Organization. H. RUBEY. *Mining & Met.*, **13** [304], 204 (1932); for abstract see *Ceram. Abs.*, **10** [10], 740 (1931). E.J.V.

Silicate Industry of U. S. (Silikatnya Promuíshlennost Severnoi Ameriki.) P. P. BUDNIKOFF. Price 2.00 R. Reviewed in *Feuerfest*, **8** [2], 28 (1932); for abstract see *Ceram. Abs.*, **11** [5], 313 (1932). M.V.K.

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of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIAL

WHAT THE ECONOMIC DEPRESSION HAS DONE FOR ME

A CONFESSION AND A LESSON

Personal Affairs

(1) Income shrunken nearly 60%.
(2) Income now below fixed commitments.
(3) Family obligations increased.
(4) Life insurance audited for the first time.
(5) More walking and less motoring.
(6) Thinking with the aid of a pencil, studying and planning on paper substituted for "day dreaming" and "hunch thinking."
(7) Charted courses in activities and expenditures rather than "drifting practices."

These are some of the benefits which have accrued to the editor personally.

Society Affairs

These personally accrued benefits are recited here editorially for two reasons: (1) They are depression effects which will result advantageously to each of us provided we so change our actions as to convert them into benefits, and (2) these effects are reflected beneficially in my performances as editor.

What depression benefits have accrued to me personally are reflected in my services rendered to the Society, and in the service which the Society will render to the members and to the ceramic industries.

The following relation analysis of *Journal* incomes and expenses is an example of these depression benefits:

The Mathematics of Journal Financing on a Non-Profit Basis

Given:

(1) Number of pages per year = (A)
(2) Number of copies issued each month = (N)
(3) Cost of typesetting and illustrating + 100% editing cost = \$6.6 per page = (c)
(4) Cost of printing, binding, and mailing + 100% editing cost = \$0.0024 per page of each copy = (p)

I. Publication cost = $Ac + pAN$

II. Advertising income required:

Subscription income = \$6.00 per member
Advertising income per page (minimum) = \$40.00
If X = number of advertising pages
Total *Journal* income is $6N + 40X$.
Equating cost and income
$Ac + ApN = 6N + 40X$

$$X = \frac{Ac + ApN - 6N}{40} = \frac{6.6A + .0024AN - 6N}{40} = \text{number of pages of advertising}$$

required to finance the *Journal*.

No. *Journals* sold per month (N)	Pages advertising required each month for 150-page *Journal*	Pages advertising required each month for 200-page *Journal*
1500	19.5	31.93
2000	17.75	31.58
2500	16.00	31.23
3000	14.25	30.88
3500	12.50	30.53

If this *Journal* should contain $208\frac{1}{2}$ total pages per issue there would have to be a minimum of $34\frac{1}{2}$ pages of advertising regardless of the number of *Journals* sold per month, because with $208\frac{1}{2}$ pages it takes all of the subscription income to pay for the printing, binding, and mailing. Both (*a*), income from subscriptions, and (*b*), cost of printing, binding, and mailing, depend on the number of copies sold. The advertising income must alone pay the cost of typesetting and illustrating when the book exceeds $208\frac{1}{2}$ pages.

Thus in our case Ac will have to equal $40X$. The required ratio of number of advertising pages to total pages printed in excess of $208\frac{1}{2}$ pages is therefore $\frac{X}{A} = \frac{c}{40} = \frac{6.6}{40}$, or 0.0165 page of advertising for each page printed inclusive of the advertising pages is required when the total number of pages amounts to $208\frac{1}{2}$ or more.

III. Ratio of editing, printing, and mailing cost per page to number of *Journals* issued:

$$\text{Cost} = Ac + pAN = A\,(6.6 + 0.0024N)$$

$$\therefore \text{ cost per page} = \frac{6.6 + 0.0024N}{N}$$

No. of *Journals* printed	Cost per page	Cost of each *Journal* copy: 150 pp.	175 pp.	200 pp.	225 pp.	250 pp.
1000	0.009	1.35	1.575	1.80	2.025	2.25
1500	0.0068	1.02	1.19	1.36	1.53	1.70
2000	0.0057	0.855	0.9975	1.14	1.28	1.42
2500	0.00504	0.756	0.882	1.008	1.134	1.26
3000	0.00460	0.69	0.805	0.92	1.035	1.15
3500	0.00428	0.642	0.749	0.856	0.963	1.07
4000	0.00405	0.6075	0.7087	0.81	0.9112	1.0125

Past Records

Here is where the editor gets his "come-uppance."

(1) A survey of how your editor has spent the SOCIETY'S *Journal* resources in excess of *Journal* income on informational service to the ceramic industries "boxes the compass" very effectively and astonishingly.

Again equating monthly cost and income:

$$Ac + ApN = 0.5N + 40X$$

we have $A = \dfrac{0.5N + 40X}{6.6 + 0.0024N}$ = the number of pages warranted by the income per month.

Year	Monthly Income: Sub. $0.5N$	Monthly Income: Adv. $40X$	No. copies monthly (N)	Average monthly number of pages: Edt.	Adv.	Total incl. 10 extra	No. pages warranted by income	No. pages excess per month	Page cost per monthly issue	*Journal* expenditure not warranted by income
1925	1281	1120	2562	167.8	28	205	188	17	$12.75	$216.75
1926	1366	1200	2733	153.8	30	193	195		13.16	
1927	1406	1240	2812	177.8	31	218	198	20	13.35	267.00
1928	1431	1160	2862	196.1	29	235	192	43	13.47	579.21
1929	1427	1120	2854	192.5	28	230	189	41	13.45	551.15
1930	1535	1120	3070	224.5	28	262	190	72	13.97	1005.84
1931	1458	800	2916	195.6	20	225	166	59	13.60	802.40
5 mo. 1932	1260	640	2520	160.0	16	186	143	43	12.60	541.80
										$3964.15

This analysis shows that since 1924 your editor has spent $3964.15 of the SOCIETY'S income on the *Journal* in excess of that warranted by the *Journal* income. This is an analytical statement of the editor's mistaken expectation that the ceramic industries would pay in full the cost of services rendered.

And that is not the whole statement of the cost of proceeding without an analytical study of "balanced budgeting."

It has been considered wise to keep a stock of the *Journals* to meet demands for them. A considerable number of "back numbers" are sold each year, but how many should the SOCIETY keep in stock? What does this stock represent in actual cost?

NUMBER AND VALUE OF BACK NUMBERS IN STOCK

Cost per copy = $\dfrac{Ac + ApN}{N}$ (including editorial costs)

	Cost	No. in stock May, 1932	Cost value	Inventory value	
1925	1.02	2377	$2424.5	@ 3¢	$71.31
1926	0.92	2357	2168.4	@ 4¢	94.28
1927	1.00	1322	1322.0	@ 5¢	66.10
1928	1.11	1619	1797.0	@ 6¢	110.14
1929	1.05	759	797.0	@ 7¢	52.13
1930	1.19	2464	2932.0	@ 8¢	197.12
1931	1.05	3994	4193.7	@ 9¢	359.46
1932	0.93	1126	1047.0	@ 10¢	112.60
			$16,681.6		$1063.14

These figures show that since 1924 we have spent $16,681.6 of the SOCIETY'S income on building up a stock of back numbers. During these 7½ years we have sold out of

this stock enough copies to realize only $5705.84 or $778 per year. We have expended from the treasury a sum of money which should today be in a cash reserve rather than frozen in "back numbers," the sales returns on which are inadequate.

Our record is not altogether shameful. We have acquired office equipment, library, photograph gallery, and permanent exhibits. The SOCIETY in addition to the *Journal* has published two bibliographies. Our frozen inventory assets are depreciated on a sliding scale and are at a low figure; thus we have not been fooling ourselves on their liquidating possibilities.

The managing of the SOCIETY, other than in publication affairs, has been unusually economical.

Our expectations of personal and corporation membership support and our ideas of what was an adequate supply of back *Journal* numbers were far in excess of realized returns.

If the SOCIETY is to render the services to the extent it has evinced a capability, there must be a larger membership support.

One thing is certain, we now have our "compass boxed"; we are going to steer clear of income wastage on expectancies.

PAPERS AND DISCUSSIONS

QUALITY PRODUCTION*

By Richard F. Bach

Objects of art of past times, if indeed they are objects of art to begin with, really were commodities in their day. As soon as we make that discovery we may reasonably conclude that objects of industrial art, or of other types of art which we find in museums must have commanded a price. Is that a crude point of view, to bring together money and art? Is not the artist, like any other worker, worthy of his hire?

An object of art, whether tea cup or cathedral, is the artistic, also the economic and the sociological expression of its time. It is just as important for us that many people admire and buy these things as it is that a few make them. It is much more important to have appreciators than it is to have artists. For out of the appreciators the artists, quite naturally, grow. The appreciators are, in practice, the consumers, the market. Through them we introduce that constructive element of all production (lately not so constructive and rarely even present) which we call profit.

The kind of business profit that comes out of industrial art is twofold. There is the immediate profit that causes the pleasant tinkle in the cash register, and there is that other profit which comes in the form of a repeat order. The repeat order is not always a question of utility, or dimension, or durability; it is a question of how the product looks.

You might say that mechanical and artistic design are two radically different things. Not by any means is that so; they are closely related. An absolutely right functional design in the end is going to be a good looking object. Consider, as examples, the typewriter or the stock ticker.

Here is a clod of earth, just a gob of clay; and here, made from it, may be a cup and saucer. You know that the difference is 290%.[1] Again, you may have a handful of some different, perhaps better, clay and there, made from it, may be a Chinese vase that has lived through centuries of time and is one of the finest assets of a museum of art. Of course, in such an example there are the additional business assets of age and rarity.

Regarding the value of skill, I had an experience to prove this. A plumber mended a drain for me. He did a good job. He did an even better job of writing the bill. I demurred, or whatever one does to a plumber under the circumstances. A corrected bill was promptly sent. The total was the same, but the itemization read like this: To time of helper, $2.50; to materials used, $2.50; partial total, $5.00. Then he had drawn one of those diagonal lines that appear on invoices at the bottom in green ink, so I would reach the shock on a clear track: To knowing how to mend a drain, $20. There *is* value in skill. I paid $20 for one lesson in placing an adequate value upon skill.

You may say that that was technical skill. There is also artistic skill. With technical skill you serve a purpose, or you establish correctly a certain mechanical activity, a satisfaction of function; with artistic skill you give pleasure and that, in the end, commands the price when the consumer selects merchandise.

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* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., Special Session, February 9, 1932.

[1] Industrial Art a National Asset. A series of graphic charts. Department of the Interior, Bureau of Education, Washington, D. C.

I like to recall that statement about Michelangelo, always related of him, although it must have appeared in every carver's life, that the figure is in the stone and it is the sculptor's task to bring it out. Michelangelo worked technically but expressed artistically: He got out of that marble block not only a differently shaped piece, but a piece which lived ever after because everybody who looked at it got a pleasurable reaction. That is where artistic expression enters, and there is no industry that can do without the technical shaping or handling of materials toward artistic ends.

Before the era of quantity production, all the work of the world was done by craftsmen, men with rounded ability, who came in direct contact with the consumer, established to their own satisfaction what kind of design would be wanted and then produced it, and afterward had the right kind of selling talk to put it over; that was the diversified and complete activity of the craftsman.

With the advent of serial manufacture those contacts disappeared. All this varied activity became specialized as well as standardized. The special abilities have been retained, and each developed to one hundred per cent of craftsmanship within its own area; but the craftsman type, as a productive factor, has been greatly reduced in numbers, and in many industries totally eliminated.

Craftsmanship, as a quality of the mind and as an ambition toward perfection, has been retained. In fact, efforts have been made on all sides to retain that particular attitude toward production which is nothing more than the desire for and the effort toward perfection; perfection in his craft was and is every craftsman's goal. The effort toward it is the measure of his ability as seen in the competitive product he makes and offers for sale.

When the inclusive activity of the craftsman was replaced by those machines, with which you are so familiar, something was left out. When those machines were first devised, what was their purpose? It was only to relieve the hand, not to replace it; it was only to do some of the things the hand had formerly done. Therefore, the machine was set to work to duplicate that particular style of design which was popular at the time the machine itself was invented. People lost sight of the fact that machines are tools in their own right.

It is only the abuse of the tool or instrument that causes trouble. Too often industry has considered the machine an automaton capable of producing of its own volition the perfect object, only to discover that the machine will produce no more and no better products than you gear it to make. The machine has too often been used as an aid toward trading down, as a means of assuring price competition, just as the great advantages offered by industrial chemistry have too often been turned to ulterior ends in the stultification of materials. Trading down seems to be a by-product of quantity production. Quality is lost sight of.

Trading down, like quantity production itself, has to do with volume and lower price, and always larger areas of distribution. But there comes a time when volume itself is reduced, as in the present depression, and then what happens? Quality of design will at least maintain a purchasing level and safeguard values. Price appeal will give you only a momentary response or else must confine your consumer level to a lower grade market.

What is the consumer's slant on that question? How many consumers care how you make your products? How many know they are made of clay? When a new dinner service is bought the chief interest and the chief selling point is appearance. That is true whether the customer is a person who wants to keep up with the Joneses or one who likes a good home environment for the sake of her children. The durability of a plate may be fairly measured by its price; wearing quality and the simple utility of the piece,

these are basic ingredients and only occasionally brought into question. Design, on the other hand, is always in question, for it is so largely a matter of opinion and personal reaction.

When I say that to manufacturers they always reply, as do the play producers: But the things we offer are what the public wants. How does anyone find out what the public wants? The manufacturer replies again: Consumers go to the stores and buy these things; we make them to be sold in the stores and the consumer chooses from what she finds there.

That is just my answer to you: They buy whatever is there. If you do not put ugly things there the consumer will not buy them. If your wife wishes to buy a dinner service she must shop in a half dozen stores; finally she selects a pattern. That is all she can do. She cannot get back to you and tell you, as manufacturers, what kind of a pattern she wants. She can only refuse to buy. In the end, she has to buy or have no dishes.

If, on the other hand, there were only good patterns, what else could she do but select a good one? The thing answers itself. It is a useless kind of trading down because it implies an underestimation of the cultural level of the consumer. You will remember what a columnist once said, that the average man is usually a good deal above the average. Consumers are, as a rule, above the average.

Watch the kind of purchases made in a selected type of merchandise. Certain patterns are available at a certain price; others cost a few cents more. You will be surprised to see what kind of people express their preference by spending the few cents more. Quite likely they do not look as though their purses could stand this extra strain. Their reactions are the measure of the higher cultural level they have reached. Not that the few cents more would necessarily indicate the quality of the product on the design side; that is too often the case, though with little reason or even excuse.

Between you and the consumer, in the strategic position, stands the dealer, the retailer. He has, unfortunately, taken advantage of that position of control. It is his effort toward volume that is responsible for your efforts in the same direction, because he represents your outlet. With the customary very praiseworthy exceptions, the retailer has been chiefly responsible for keeping the consumer's taste at a lower level than was necessary. That is being corrected slowly through museums, through schools, through self-training, and other means. The retailer is slowly being educated to sell in terms of design, and not a little of the effect upon him in this direction comes by the shortest line, direct from the consumer. When that has been achieved, you will get your opening, because you will be able to offer the sort of thing which, had you direct access to the consumer, you could offer now.

One point more about the consumer. She is now in a position to make demands. You, like many other industries, have lived through a period in which supply preceded demand; the economic system has been inverted. You are now entering a period, to which this depression is but the door, in which you will rediscover that demand has to precede supply.

When the consumer comes back to the stores to buy the products of your factories she will bring to the task an equipment that she never had before. During the time when she has not been buying she has been learning just the same. Her level of taste has gone up. The schools have not closed. More books have been sold than ever before. The museums have been filled. People have stored their minds with information that will be useful when they buy again. The best thing I could say to you is to be forearmed against that impending time when the consumer will come back and will want a better designed product than you have in your stock now. That is more than advice; it is almost a warning.

It is the appearance of your tableware that counts. It is the appearance of your bathroom equipment that counts. If that is not the case, why have you been making these changes, of which, indeed, some have been improvements? Why does your product appear as it does today in your catalogue as compared with ten years ago? I am old enough to recall the different stages through which the bathroom has gone, and have followed design of tableware through years of both slow and rapid variations of type, style, and period. Too many of the changes have not been advances. What is more, you all know that many of your pattern changes have achieved primarily a similarity to the competitors' successful numbers!

To aid you, you need research in design. You have begun it in the Fellowship study at Ohio State University. Keep up that good work. It is of the greatest importance to you as an industry in your relation to the public to be able to point to something like that and say: We are making studies all the time to improve the design of tableware.

Modern business, as I see it, is nothing more than service; a hackneyed word, but there seems to be no adequate substitute. That is, service of which the commodity is the embodiment. It does not mean only that the object is so big, so heavy, so thick, but primarily that in spite of all of those conditions (or because of them, in part) it also is a good-looking thing that you are glad to own and the use of which brings repeated pleasure.

In this service, as I see it, design is the chief ingredient. That is so because of your relations to the consumer. The consumer begins with the exterior, you begin with the material. You work out toward the appearance, but the consumer has only the appearance to go by and has to take your word, or else bitter experience, for the utility, for the durability, and for a number of other qualities that can be discovered only after the purchase has been made, unless these qualities can be assumed on the basis of your reputation as a manufacturer.

Just one more emphasis on quality. I have quite intentionally used the words "quality-production" and have referred to "design-quality," hyphenating the words. Too many people think of quality only as material quality. Philosophers and sociologists repeatedly scold us for being materialistic. We have lost out of the mix that essential quality which makes the material interesting. That quality, from the consumer's angle, is design, for it is essentially that element of quality in your product that you sell to the consumer.

We must remarry quality and quantity. I think it can be done. It can be done with a maximum success because we have ingredients in our lives, our community life, that are quite different from any that have existed before. We have a democratic point of view toward all of our industrial art simply because the right of the individual to select, to buy, and to refuse to buy is part of the constructive force toward the development of design.

There are in all industries numerous well-studied technical hazards. I have just listened to a most admirable study, touching the ceramic industry, on dust hazards. There is a design hazard too, because you hazard, you jeopardize your business chances if your design is not qualitatively high. Toward that end you will, as a matter of economic good sense, bring quality and quantity together again. And you will find, in the words of the oft-quoted news-break of the small-town editor that they lived happily *even* after.

METROPOLITAN MUSEUM OF ART
DEPT. OF INDUSTRIAL RELATIONS
NEW YORK CITY

THE IMPORTANCE OF GOOD DESIGN IN CHINAWARE*

By G. S. Stone

Two types of individuals who are most necessary to manufacturers, jobbers, and retailers are the stylist and the artist. Unfortunately, many are masquerading under both titles who cannot perform the functions which their titles imply and who have been connected with industry generally and with the china industry particularly. Individuals who, on the contrary, have had the proper background to permit them to give both constructive as well as destructive criticism have been a distinct and invaluable help to us in the field of retail distribution.

If an artist has had a thorough background of line, design, and color, his innate ability plus wide experience in general design fits him to make pleasing combinations of color. It is unfortunate that there are still too many good artists who believe that giving their talents to the machine is a compromise of their art. Such a feeling is rapidly being overcome, and soon the public will have the privilege of living in more beautiful surroundings made possible by the artist who has commercialized his talents, thus allowing retailers to exhibit beautiful things at prices which hitherto they could not afford.

The artist who has realized the possibilities of working with the machine, however, still limits his best work to canvas, although a design on dinnerware requires even better work and more minute detail. Nothing has a closer or more frequent inspection than designs on dinnerware, for in the majority of cases the same china appears on the table three times daily.

The manufacturer, jobber, and retailer alike can profit to a great extent from the artist, although the efforts of the artist cannot be taken *carte blanche*. His work must be tempered to be successful.

Realizing that the artist may be a decided help to our business, let us consider dinnerware patterns particularly. Admittedly, this is a nation of apists. Mrs. Jones wishes to do and have the same things as her neighbors. She, however, does not want her house furnished in the same way or to have the same dinnerware on her table. All of us enjoy individuality.

Admitting that many people have poor taste, the sale of such magazines as *House and Garden*, *Vanity Fair*, etc., alone proves that thousands of people are interested in being correct and having properly designed dinnerware. Inferior dinnerware is still being sold mainly because good ware has not been available until recently. The public cannot be expected to change its buying habits until it has been shown dinnerware of good design and has become familiar with it.

During 1927 and 1928 a wave of modernism swept over the United States, particularly the New York district. All of the large stores held "modern exhibitions." Buyers who did not know what the term "modern" meant went to Europe and asked dinnerware manufacturers to make "modern" shapes and designs. The manufacturers had no more conception of what "modern" meant than the buyer, so together they produced some terrible designs.

I made a trip through almost every European country early in 1928 trying to cover the "modern" field in ceramics. In many cases, the ware being turned out for this market and called "modern" was absurd. When the merchandise arrived it did not retail. So bad were the sales results that the modern movement was disclaimed. So the wave passed. Money was lost instead of gained because of the lack of intelligent art work. Only the best modern ware survived and today it sells as well as ever. The movement will slowly accelerate, mainly because it interprets the way we are living. The modern

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* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Art Division).

design which did live was an American interpretation. Designs made for America should cater to the type purchased and understood by Americans. For example, the things sold in England do not sell here. The designs which France makes for America would never retail there.

If such is the case, why are so many foreign-made products purchased? In the first place, people have been brought up to believe that they should buy "china" for their tables and that earthenware or "semiporcelain" are cheap products. That idea alone, however, does not keep the people from buying the American products. English earthenware sells in large quantities in this country. The problem is one of design rather than of body. English earthenware is popular because English designers have taken the best that the past has done and interpreted it in a 1932 manner. Even before English sterling dropped in valuation, distinctive selling designs came from England.

Chinaware in fair quality is coming into this country at prices not much greater than the cost of domestic earthenware, making the problem even more acute. This cheap chinaware will not sell in any volume with poor designs containing only the ordinary French, Czechoslovakian, or German combinations of coloring. Much of this imported ware has been successful through the use of designs made up here and taken abroad. Unsatisfactory designs are never money makers.

Too much emphasis cannot be placed on the fact that design or pattern sells dinnerware. A fair-quality body and interesting shape are necessary although retail selling is dependent on interest in the pattern itself. The purchase of dinnerware is similar to the purchase of an automobile in that appearance is considered before price or performance. The quality is not regarded as important as new patterns are more available than they were a decade ago.

Since the American manufacturer has to compete with imported china, good earthenware designs from England, lower sterling valuation, etc., the only way in which he can sell the American buyer the bulk of his goods is by producing more distinctive and better designs.

The American public has come to think of domestic dinnerware as a type of informal design such as three sprays and a line, three sprigs of nasturtiums, three sprigs of pink roses as small as rosebuds or as big as cabbages, three sprigs of pansies, etc. Such designs have always been associated in this market with such a cheap price that neither the manufacturer nor the retailer could make a profit. The only type of dinnerware which commands more money is that of a more formal type of design, more distinctive in appearance, which can only be turned out by a good artist. The public has always associated this type of pattern with imported dinnerware.

If the American manufacturer will supply a fair selection of ware, using proper shapes and better designs, he will be able to wipe out the myth that exists in the minds of many American retail customers, that good dinnerware is made only abroad.

R. H. Macy and Company
New York, N. Y.

TRENDS OF THE NEW YORK BUYING PUBLIC*

By Ruth Canfield

The first clay pots were valued chiefly for their utilitarian qualities. Perhaps they were better loved because, for purposes of identification, some member of the family group drew pictures on these clay vessels with tools suited to their use. Here is real vitality promoting each force in the performance, giving in most primitive pieces, a feeling

* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Art Division).

of unity and of fitness of the ware to its use, and of decoration to the form and to the material.

This early state of primitive reality has changed to one of sophistication and so-called civilization where numberless formalities govern nearly every daily move and motive. The need for some object, such as a pitcher, which holds a certain amount, pours well, and has the proper weight, must be satisfied by discovering something to fulfill that need among the maze of products given the world through traditional sources or the more aimless recent designs of those whose objective is to produce different pitchers.

To know what one wants precisely seems to be a "modern behaviorism," and to get what one wants is the "modern attempt." Few people, however, are so situated that they can fulfill these needs by products of their own creation. They usually compromise by buying the "best available" for their need while they complain that "little is available" which suits their need. Traditional patterns may give more satisfaction since they have stood the test of time and therefore must have fulfilled satisfactorily both the practical need and the esthetic to prove their real vitality. If there were a brief period in which each individual could make the things for which he has a positive need, there must surely result a new group of created designs, practical and modern.

The owner of one of the finest shops in New York, noted for those objects both practical and decorative which form the treasure house of exacting interior decorators, recently stated that there is an actual dearth of ceramic and metal ware of the types suited to her clientele. She could, even now, easily double her yearly sales if suitable ware were supplied. It is an ironical fact that Rena Rosenthal can make this statement while the manufacturers of this type of ware are bemoaning "hard times."

This same shop is stocked largely with European products, European only because the sources here do not satisfy the demands of the discriminating New York buying public. To make quite clear their feeling in this regard Mr. Rosenthal stated recently that his patrons originally wanted only imported articles, preferably old ones. Later he found that they would buy beautiful things, even though they were American-made objects. Now he feels that there is a trend in the direction of actual demand for American products rather than for European.

Together with the past period of abnormal inflations in which extravaganzas of all sorts grew up and died out, came the cry for gaiety, for the style of decorative objects so recently typified by the Wiener Werkstätter group of Vienna. Vally Wieselthier has shown many good examples of this type of ware.

The times have changed and people are demanding more for their money. We have probably swung into an ultra-conservative mood, although, echoing the Rosenthal shop, the period in which stark white porcelains were the only ceramic ware demanded, figuratively speaking, is now nearly a year past. Most of the New York shops carry lines of all shades of white at the present time, but the Rosenthal shop found that the demand for polychromes as well as those delicately shaded combinations of color had lessened and that white and metallic surfaces were becoming important.

Nearly every shop can attest to the fact that the public is demanding finer quality of materials, technique, decoration, and color. Each element entering into the finished product as well as the ensemble is scrutinized and judged with far greater intelligence and zeal than was used during that period just passed when the dramatic effect was sufficient aim for most purchasers. Subtlety is necessary in the combination of these qualities; for example, the suitability of form to the body and of the color to the form and the body. Each element should contribute to the practicability of the object as well as to its beauty, and if originality of idea does not dominate the whole, a demand is made for just that element. One shop is constantly asking for new table decorations which

measure up to all of the suggested standards and of which idea the fruit or flower bowl with matching candlesticks is the parent.

Quality is the foremost characteristic of the vogue. In the field of decorative ceramics, the work of the Italians, Ginori and Lenci, is an indication of this style. The norm of demand is demonstrated by such practical pieces, as candlesticks, fruit bowls, coffee cups, etc., produced by Wedgwood in white, blue, or black and white. At present the interior decorators are interested in 18th Century reproductions of heavy porcelains and earthenware in a wide range of mannerisms not suited to mass production. Some of these are oval bowls whose sides are pierced from the top to the base and which have decorative handles, square tea caddies with brush decorations in blues, violets, or pinks, and the Empire type of porcelains with solid bands of rich reds, lemon yellows, and blues with gold decorations. The tendency in color is to plain richness with much interest in white and pastels, especially pink. Beautiful forms in beautiful colors, with perhaps a lining of contrasting color, is as good a rule as any. It is almost impossible to separate the elements of the popular ware, to isolate any quality without discovering that that quality is an inseparable part of a complete unit. Each shop shows pieces among its most saleable ware which disprove the style trend rules. These exceptions are those rarely beautiful things which need no date to prove their value.

The conclusion drawn from this survey is that of the artist *versus* the buying public; the artist incloses himself in his chosen place and therein makes that which he calls beautiful and of which he expects the public to approve to the extent that he will be subsidized through sales and may go on producing. If he is independent of this subsidy from the buying public I have no quarrel with him and if what he produces is beautiful, it will live, but if it is not, it will surely die. If, on the other hand, he is dependent upon sales he must go out and find what he can produce that the world will approve of. He may be able to convert some to his way of thinking and working, but there is great stimulation in keeping up with the current demands of the modern public.

Director of Arts
Henry Street Settlement
New York, N. Y.

ACTIVITIES OF THE SOCIETY

NECROLOGY

Mrs. Bellamy Storer

The death of Mrs. Bellamy Storer (Maria Longworth), founder of Rookwood Pottery in Cincinnati, occurred in Paris, France, on May 4, 1932. Mrs. Storer was elected to Honorary Membership in the American Ceramic Society at the time the Society was founded and followed its growth and development during the ensuing years with interest and coöperation, evidenced by the accompanying interest of those associated with her in the Pottery, chiefly Stanley G. Burt.

Mrs. Storer was eighty-three years old at the time of her death, and her life was crowded with the achievement of civic enterprise in Cincinnati, her work with Rookwood Pottery, and she attained national repute as the wife of Bellamy Storer, who served as ambassador from the United States to Austria. The same active participation that urged her to found Rookwood Pottery, as well as to organize the Cincinnati Music Festivals and found the first children's hospital in Cincinnati, was carried on into her position as the wife of a man in diplomatic service.

Of all her varied interests and attainments, however, her work with Rookwood Pottery is of the most interest to the members of this Society. Excerpts from Mrs. Storer's own story of Rookwood Pottery are taken from a brochure which she wrote in 1895 and published in Paris in 1919.

In May, 1879, I applied for permission to make experiments in pottery at the Dallas "granite" ware factory. Mr. Dallas consented to have pieces made in the clay and fired especially for me. Mr. W. W. Taylor (afterward president of the Rookwood Pottery Company) happened to be with me the first time I stopped there. It was, I think, the first time either of us had ever been inside of a pottery, and on that day we made the acquaintance of Mr. Joseph Baily, since then for many years superintendent of the Rookwood Pottery.

Here I made my first experiments in clay, glaze, and color. I was continually discouraged by the fact that the hard fire of the granite-ware kilns destroyed nearly every color I used except cobalt blue and black. Mr. Baily added a dark green to this limited palette, and I found a claret brown that would stand the heat. Lastly, we obtained a light blue and a light green, but we had no red and no pink or yellow, and the effects were cold and hard.

I was feeling discouraged one day in the spring of 1880, when my father said to me: "If you are really in earnest in wanting to have a pottery of your own, you may take an old school house that I bought at a Sheriff's sale last week and fit it up to suit yourself."

I called the pottery "Rookwood" because it was the name of my father's country place on Walnut Hills, where I had lived from one year old to twenty years.

My first disappointment was the discovery that we might have started it in a cleaner and quieter place. I had had a vague idea that we must be on the river in order to have numerous barges laden with clay conveniently near. I discovered later that the quantity of clay used by an art pottery is comparatively small; also that our best white clay had to be brought from Chattanooga by rail. Our first and only boat load of yellow clay arrived at a time when the river had retired low into its bed, leaving the pottery high and dry; so that the cost of hauling the clay from the boat was as much as it would have been from the railway station.

Our first kiln was drawn in November, 1880. I had not yet found any decorators, and except my own work, we had made only pitchers, teapots, etc., of simple red or yellow clay, and of pretty shape, after the fashion of early Doulton ware.

Two efforts were made to damp my ceramic ardor at the outset. The first was a letter from old Mr. Dallas, at whose granite-ware factory I had been working, advising me against undertaking such a task, and pointing out the difficulty and probable failure of it as a business. The other warning was a threatened injunction from an artist, who had been painting on clay at Coultry's pottery, and claimed to have got a patent for the "process." A reporter from the *Times* came down one day to interview me about this,

saying that we were going to be "enjoined." Of course, I paid no attention to this, and nothing of the kind ever happened.

It seems strange that any one can talk of "originality" in a process, which, technically, is as old as Egypt. Neither was the mixing nor the use of the colors any secret whatever, and it was simply an artistic decoration of colored slip on clay.

What *is* peculiar and distinctive in "Rookwood" pottery is its glazing. Aside from the merit of the decoration, the early pieces were hard and staring in effect, and cold in color. The rich glow is given solely by the special glazing which belongs to Rookwood pottery alone. This warm effect of color through glaze I discovered in 1883, when attempting to give a rich tone to red clay under the glaze. Every bit of red clay made before this time was a dull chocolate brown when glazed.

To my own regret and that of many artistic friends, the yellow glazed ware (including "tiger-eye" and "goldstone") which gave us the gold medal in Paris in 1889 and was the most original work ever made at Rookwood has been abandoned of late years.

During the early years of the Pottery, I desired very much to have the clay and kilns placed at the service of persons not connected with the Pottery, who desired to make decorated pieces for themselves. We also tried to establish a school of pottery painting, with Miss Fry, one of our decorators, and Miss Newton, my private secretary, as teachers. Both of these undertakings were a financial loss and a drag upon the work of the Pottery itself; and when in 1883 Mr. Taylor became manager in the hope and expectation of making the Rookwood Pottery a paying and permanent institution, these two branches had to be abandoned.

I don't suppose any undertaking ever had so much gratuitous advertising as the Rookwood Pottery, because it was a woman's. Nevertheless, as a business its success was very slow. In the beginning, when it was not a matter of importance whether it paid or not, a great many new things were tried and experiments made in search of improvement in material and effect. The old pottery building, too, was very inconvenient. It was built on the side of a hill, so that there were many stairs to climb and dark passages to go through, and each vase had to travel far and run many risks before arriving at the kiln. Very careful handling too, of the unfired pieces had to be learned by experience, and after many accidents. To break an undecorated piece of clayware is only a slight loss, but the Rookwood pieces have all the artistic work put on them when they are still in the clay, and the greatest risk of breaking and warping comes after the decoration has been painted on the piece. I mention this because it is one of the reasons why even small pieces must be sold at a price which is sometimes commented on and criticized. Many a time I have almost wept over the clay fragments of what had been a beautiful work of art, or at a great fire-crack in a piece just drawn from the kiln.

It was only after 1883, when Mr. Taylor took charge as my manager, that things began to assume a "business" air, and the artistic Pegasus had, to a certain extent, to be harnessed to the commercial art.

It is more philanthropic in the end to give sure and steady employment to people of talent and skill than to indulge only in spasmodic and intermittent fits of generosity. One of the pathetic things in the pursuit of beauty in art of all kinds is that it is hard to get a living by it.

The Rookwood Pottery has been a fortunate exception. It was at first an expensive luxury for which I, luckily, could afford to pay. Since 1889 it has made itself a solid paying industry. It is another example of the "prophet without honor," and (if I may be allowed a degenerate pun) even without "profit" in its own country, until Paris, in the Exposition of 1889, gave to Rookwood a gold medal. From that time the demand has more than equalled the supply. It was in 1891 that I presented the Pottery to my friend, Mr. Taylor, who turned it into a stock company. Its commercial success has been due entirely to his efforts as manager.

Mr. Joseph Baily came to the Pottery in its second year. Except for a temporary absence, he has been there ever since, and has been invaluable in his improvement of clay and glaze, and efforts toward technical protection. In his leisure moments too, he has succeeded in making the very best pieces (in color) of hard fired red glaze in imitation of the old Chinese that I have seen here or in Europe.

A pottery like this is such a conglomerate body, that it is hard to say who has or has not helped to make it what it is. Miss Newton did the most efficient work in technical criticism, and in the selection of shapes and decoration.

The imaginative fancy of Mr. Pitts H. Burt also created some of the most graceful and poetic of the later forms, a matter of the utmost importance in the making of artistic pottery.

The decorators have all assisted in proportion to their ability. Mr. Valentine, Mr. Daly, and Mr. McDonald, have been longest working there together, and yet each one has kept a marked individuality, and each one excels in certain things. Mr. Shiryama, too, who came many years ago, has done much beautiful work, and his Japanese delicacy of touch is unrivaled. These four stand foremost because they have both talent and experience. All our decorative artists must have talent and an education in drawing and at least in water color painting before coming to the Pottery; but beyond this lies a study of the change of colors by firing—of the alterations produced by the glazes, etc., which is in itself an education.

The greatest artist living would make only daubs of Rookwood decoration unless he took time and infinite patience to learn the methods. Not only each color has to be studied, but every dilution and every mixture of color, making an endless multiplication of effects and possibilities. Therein lies the secret of the attraction of ceramic work. It is the eternally new, the ever changing. It is like the search for the philosopher's stone. Anyone who has tried to study it scientifically, or even dipped into its chemical possibilities, is drawn on by its elusive fascination.

I have been asked so often about the early history of the Rookwood Pottery, that I have decided to print this sketch written in 1895, which gives details that may be of interest.

Its subsequent history has often been made public, and is familiar to everyone who knows or cares about decorative art. This article describes only my personal experience and work during its first twelve years of existence; it is therefore a scrap of autobiography.

SIMPLIFICATION OF PAVING BRICK SIZES

The annual meeting of the Permanent Committee on Simplification of Variety and Standards for Vitrified Paving Brick of the U. S. Department of Commerce, was held in Washington, April 14, 1932.

The survey of shipments prepared by the National Paving Brick Association showed that the total percentage of the six recognized varieties designated previously by the Committee, was only 56.1% of the total shipments. The Committee decided to add to the recognized list the 3 x 4 x 8½ inches vertical fiber lug brick, which in 1931 constituted 22.6% of the total shipments. It also eliminated from the recognized list the 3½ x 4 x 8½ inches vertical fiber lugless brick which, during the past three years, has averaged only 2.8% of the total shipments.

This makes the sizes and types now recognized by the Committee as follows:

Type	Size		
	Depth (inches)	Width (inches)	Length (inches)
Vertical fiber lugless	2½	4	8½
Vertical fiber lugless	3	4	8½
Repressed lug	4	3½	8½
Wire-cut lug (Dunn)	4	3½	8½
Wire-cut lug (Dunn)	3	3½	8½
Vertical fiber lug	3	4	8½

The above sizes and types in 1931 constituted 75.9% of the total shipments.

O. W. RENKERT
Representative for the AMERICAN CERAMIC SOCIETY

LOCAL SECTION NEWS

Pittsburgh Section

Members of the Pittsburgh Section held a plant-inspection meeting on May 10, 1932. About forty persons visited the plants and fifty-five attended the dinner and the evening program. J. W. Hepplewhite gave an address illustrated with lantern slides.

St. Louis Section

On April 30, 1932, members of the St. Louis Section of the AMERICAN CERAMIC SOCIETY held an inspection trip at the plant of the A. P. Green Fire Brick Co., Mexico, Mo. The committee in charge of this trip was Henry Perry, J. L. Crawford, F. E. Bausch, and J. W. Wright.

NEW MEMBERS RECEIVED IN APRIL

CORPORATION

Finzer Brothers Clay Co., R. C. Bahler (voter), Sugarcreek, Ohio.
North American Refractories Co., E. M. Weinfurtner (voter), National City Bank Bldg., Cleveland, Ohio.

PERSONAL

P. M. Connor, Metallurgist, Newton Steel Co., Monroe, Mich.
Rolland Roup, 4372 N. Wildwood Ave., Milwaukee, Wis.; Ceramic Engineer, A. O. Smith Corp.
Nell Steele, Librarian, Armour Institute of Technology, 3300 Federal St., Chicago, Ill.

STUDENT

Robert Edward Hormberg, University of Cincinnati, Cincinnati, Ohio.
Francis Joseph Zvanut, University of Missouri, Rolla, Mo.

Membership Workers' Record

CORPORATION		PERSONAL	
J. M. McKinley	1	A. I. Andrews	1
Office	1	W. N. Harrison	1
	–	Office	1
Total	2		–
STUDENT		Total	3
M. E. Holmes	1	Grand Total	7
H. S. Nash	1		
	–		
Total	2		

NOTES AND NEWS

NEW JERSEY CLAYWORKERS' ASSOCIATION

SUMMER MEETING

Asbury Park, N. J., Friday, June 17. This meeting is always profitable and enjoyable; excellent social events are planned and a good opportunity is offered to broaden and deepen personal friendship and acquaintance.

The members of the AMERICAN CERAMIC SOCIETY have been especially invited to attend this meeting.

The American Society for Testing Materials will meet at Atlantic City the following week, June 20–24. This combination of meetings makes an ideal vacation for it affords the opportunity to meet ceramists engaged in a variety of ceramic manufacturing lines.

Program for New Jersey Clayworkers' Association Summer Meeting

The meeting will be held at the Berkeley-Carteret Hotel, Asbury Park, N. J., the opening session being at 10:00 o'clock Friday, June 17. Speakers of prominence will address the members on "Advertising and Merchandizing of American Ceramic Ware." The Annual Golf Tournament will be held in the afternoon, with bridge for the ladies and in the evening a shore dinner and dance will be scheduled. Special week-end rates will be provided by the Hotel for members of the AMERICAN CERAMIC SOCIETY who plan to attend this meeting as guests of the Association. Arrangements may be made with G. H. Brown, Rutgers University, New Brunswick, N. J.

EXAMPLES OF RESEARCH INVESTMENTS

Progress in Research at Mellon Institute during 1931–1932

According to the *Nineteenth Annual Report* of the director, Dr. E. R. Weidlein, to the trustees of Mellon Institute of Industrial Research, Pittsburgh, Pa., the sum of $722,541 was received by the institution from industrial fellowship donors during the fiscal year ended February 29, 1932. The total amount of money appropriated by donors to the Institute for the past 21 years was $8,277,018, all of which was expended in defraying the cost of scientific investigations conducted for these companies and associations. Throughout the year covered by the report 75 industrial fellowships, employing 176 scientists and engineers, were in operation. At the close of the year 58 fellowships were active, and of these 28 have been at work for 5 years or longer and 13 have concluded more than 10 years of research.

In reviewing the progress that has been made since 1911, when the industrial fellowship system was established, Mellon Institute has had fellowships on 230 distinct subjects, on which 775 scientists and engineers have been engaged. In all, during the period 1911–1932, 313 fellows and 357 fellowship assistants of the Institute have completed their services to science and technology in the institution and have entered the fields of industry and education. As trained additions to the forces of manufacturing and teaching, these men constitute the Institute's greatest contribution to humanity.

Training Course in Porcelain Enameling

A practical training course in Porcelain Enameling will be conducted during the week of June 20, 1932, the course being sponsored by the Ferro Enamel Corporation, Cleveland, Ohio. The instruction will be based on J. E. Hansen's book, Advanced Technique of Porcelain Enameling. The tuition for this course will be $25.00. The schedule for this course follows:

June 20

Metal Base for Enameling
Sandblasting and Pickling
Mill Room Practice
Mill Additions

June 21

Application of Enamel
Drying and Brushing
Firing

June 22

Inspection
Graining and Decorative Finishes
Shop Troubles

June 23

Symposium on Shop Troubles
Process Control and Control Methods

June 24

Wage Incentives
Production Methods

June 25

Cost Accounting and Budgeting in Enamel Shop
Development in Enameling Furnaces and Equipment

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QUARTER PAGE	18.00	16.50	15.00	13.50
EIGHTH PAGE	9.75	9.00	8.25	7.50

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BUYERS' GUIDE

A

Aloxite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.

Aluminum Oxide (Fused)
The Exolon Co.

Ammonium Bifluoride
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Ammonium Carbonate
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Antimony Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

B

Ball Mills
Hardinge Co., Inc.
Hommel, O., Co.
McDanel Refractory Porcelain Co.

Ball Mills (Laboratory Type)
Ceramic Color & Chemical Mfg. Co.
Hardinge Co., Inc.
Hommel, O., Co.

Barium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Barytes
Hommel, O., Co.

Batts
Carborundum Co. (*"Carbofrax Aloxite"*)

Bitstone
Potters Supply Co.

Blocks (Refractory)
Carborundum Co

Borax
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.

Borax Glass
Pacific Coast Borax Co.

Boric Acid (Anhydrous)
Hommel, O., Co.
Pacific Coast Borax Co.

Boric Acid (Crystal, Granular, or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.

Brickmaking Machinery
Hardinge Co., Inc.

Bricks (Refractory)
Carborundum Co. (*"Carbofrax Aloxite"*)

Burners (Natural Gas)
Swindell-Dressler Corp

C

Carbofrax (Refractory Products)
Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

Carbonates (Barium, Lead)
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Caustic Soda
Ceramic Color & Chemical Mfg. Co.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.

Cements
Carborundum Co.

Ceramic Chemicals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
Philadelphia Drying Machinery Co.
Swindell-Dressler Corp.

Chromium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Clay (Ball)
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
The Roessler & Hasslacher Chemical Co.
Spinks Clay Co., H. C.

Clay (China)
Ceramic Color & Chemical Mfg. Co
Drakenfeld & Co., B. F.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
Hommel, O., Co.
Paper Makers Importing Co.

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- Fire Brick
- Imported Paris White
- Domestic Whiting

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BUYERS' GUIDE (continued)

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Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay Co.
Spinks Clay Co., H. C.

Clay (Enamel)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.

Clay (German Vallendar)
Ferro Enamel Corp.
The Roessler & Hasslacher Chemical Co.

Clay Miners
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay (Potters)
Old Hickory Clay Co.
Spinks Clay Co., H. C.

Clay (Sagger)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay Co.
Potters Supply Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay Tests
Swindell-Dressler Corp.

Clay (Wad)
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wall Tile)
Kentucky-Tennessee Clay Co.
Old Hickory Clay Co.
Spinks Clay Co., H. C.

Clocks, (Gauge Board)
Ferro Enamel Corp.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Colors
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel Co., O.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Conditioning Machinery
Philadelphia Drying Machinery Co.

Conveyers (Clay, Sand, Brick, etc.)
Philadelphia Drying Machinery Co.

Cornwall Stone
Hammill & Gillespie, Inc.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Cornwall Stone (Imported)
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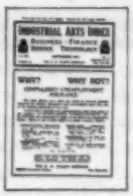

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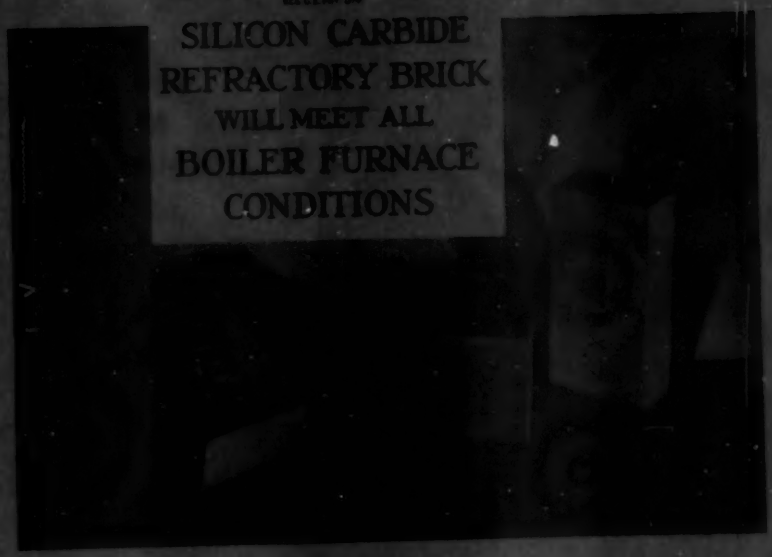

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